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PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

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ABSTRACTS 779–1557

VOLUME 54 **FEBRUARY 1951** NUMBER 638

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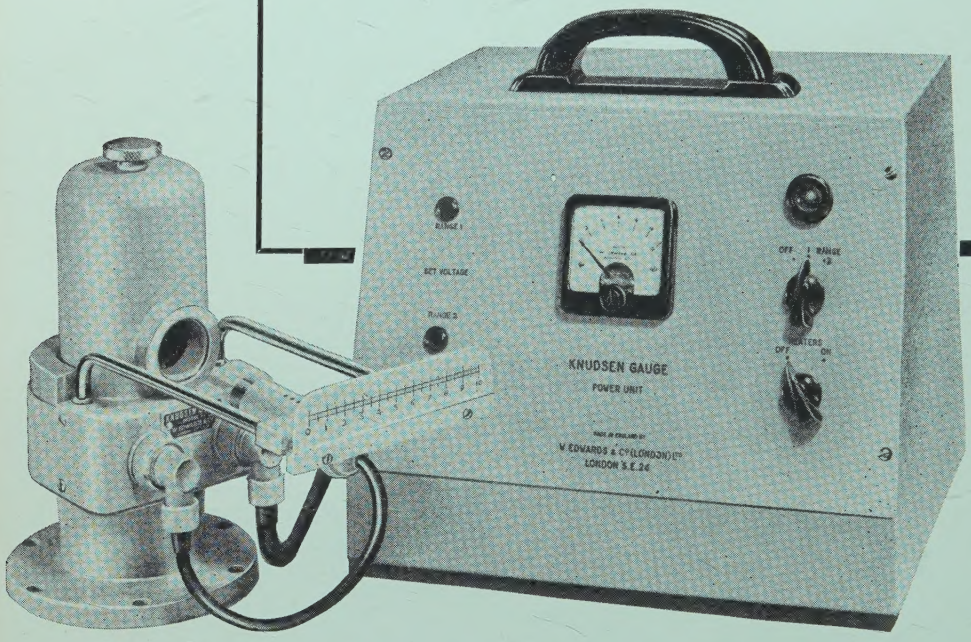

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RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

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Non-destructive testing
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Electrical and magnetic measurements and instruments
Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination
Metallurgy

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 53 (195 and the Supplement published with the Index to Volume 53 (1950). Reprints of the List of Journals (195 and the Supplement (1950) can be obtained from The Institution of Electrical Engineers, Savoy Place, Londo W.C.2, price 2s. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepte for errors.

Journals marked * are not received regularly.

Amer. Inst. Elect. Engrs Stand.	*American Institute of Electrical Engineers Standards.* 33 West 39th Stree New York 18.
Brit. Elect. Auth. Utilis. Res. Rep.	*British Electricity Authority. Utilisation Research Report.* British Ele tricity House, Great Portland Street, London, W.1.
**Bull. Inst. Theor. Astron.*	*Bulletin of the Institute for Theoretical Astronomy.* [Abstracted b *Astronomical News Letter.*]
Bull. Tokyo Inst. Techn. Ser. A and B	*Bulletin of the Tokyo Institute of Technology, Series A and B.* Oh-Okayam Meguroku, Tokyo.
**Foto-Kino-Tech.*	*Foto-Kino-Technik.* [Abstracted by *Photographic Abstracts.*]
**Ingén. et Tech.*	*Ingénieurs et Techniciens.* [Abstracted by Metropolitan-Vickers Electric Co.]
**Int. Ass. Terr. Magn. Elect. Bull.*	*International Association of Terrestrial Magnetism and Electricity. Bulleti* 6641 32nd Street, N.W., Washington 15, D.C.
**J. Metals*	*Journal of Metals.* [Abstracted by Metropolitan-Vickers Electrical Co.]
**Proc. Soc. Exp. Stress Anal.*	*Proceedings of the Society for Experimental Stress Analysis.* [Abstracted b Metropolitan-Vickers Electrical Co.]
**Quart. J. Exp. Psych.*	*Quarterly Journal of Experimental Psychology.* W. Heffer, 4 Petty Cur Cambridge.
**R.C. Ass. Elettrotec. Ital.*	*Rendiconti della Riunione Annuale dell' Associazione Elettrotecnica Italian* Via S. Paolo 10, Milan.
**Rev. Gén. Chem. de Fer*	*Revue Générale des Chemins de Fer.* [Abstracted by *Railway Engineerin Abstracts.*]
Rev. Telecomun.	*Revista de Telecomunicación.* Apartado 936, Palacio de Comunicacione Madrid.
**Rly. Mech. Elect. Engr*	*Railway Mechanical and Electrical Engineer* (formerly *Railway Mechanica Engineer*). [Abstracted by *Railway Engineering Abstracts.*]
**Rubber*	*Rubber.* [Abstracted by the Research Association of British Rubbe Manufacturers.]
**Sci. Ind. Photogr.*	*Sciences et Industries Photographiques.* [Abstracted by *Photograph Abstracts.*]
U.R.S.I. Spec. Rep.	*U.R.S.I. Special Report.* The General Secretariat, Union Radi Scientifique Internationale, 42 rue des Minimes, Brussels.

MATHEMATICS 51

512.99

779. A note on Weyl's inequality. V. S. NANDA. *Indian J. Phys.*, **24**, 181–4 (*May*, 1950).

Weyl's inequality is deduced from the commutation relation satisfied by the co-ordinates and their conjugate momenta. A.

517.942.7 : 530.145.6

780. Numerical determination of fundamental modes. D. A. FLANDERS AND G. SHORTLEY. *J. Appl. Phys.*, **21**, 1326–32 (*Dec.*, 1950).

A convenient and practical method of numerical determination of the fundamental eigenfunction and eigenvalue in a class of linear eigenvalue problems has been developed and applied in 2 and 3 dimensions. The method is based on use of a network and of difference equations, but departs from previous methods in that it is not iterative. Rather, a polynomial operator is applied to a trial function just once, to accomplish a determinable degree of reduction in all eigenfunctions other than the fundamental that are contained in the trial function. In the case of the diffusion equation, the polynomial operator is a Chebichev polynomial of a simple averaging operator. It is shown that this operator, when of degree m, is "better" than any other polynomial operator of this degree and much "better" than m iterations of a simple averaging operator—"better" in the sense of accomplishing to a greater degree the elimination of all unwanted eigenfunctions. Techniques for the use of computing equipment for application of the polynomial operator are discussed. By orthogonalization, the method can be applied to modes other than the fundamental. A.

517.942.82 : 530.145.6

781. Determination of eigenvalues using a generalized Laplace transform. M. D. FRIEDMAN. *J. Appl. Phys.*, **21**, 1333–7 (*Dec.*, 1950).

The classical eigenvalue problems of mathematical physics are solved by means of a Laplace transform extended, not over the interval $(0, \infty)$ but over the interval of interest for the differential equation. The method is applied to the Hermite, Laguerre and Bessel equations and to the equation for the hypergeometric polynomials which include the Legendre, Chebichev and Jacobi polynomials as special cases. A.

517.947

782. Solution of generalized wave equations of order higher than 2. I. S. PRAKASH. *Proc. Indian Acad. Sci. A.*, **31**, 240–60 (*April*, 1950).

Using the method of Fourier integrals, solutions of wave equations of the form $\prod_{r=1}^{n} (\Box + \chi_r^2)^{p_r}\psi = f$, where $\Box$ is the d'Alembertian in $m + 1$ dimensions, the p's are positive integers and f is a given function of the co-ordinates, are obtained for arbitrary m and n. The solutions for the two cases, viz. when all the χ's are different ($p_1 = p_2 \ldots = p_n = 1$) and when all the χ's are the same ($p_1 = p$, $p_2 = p_3 \ldots = p_n = 0$) are considered separately in greater detail. It is shown that the usual δ-type singularities on the light cone do not appear in the solutions of the wave equations of order higher than 2 in the case of four-dimensional space-time which is of physical importance. A.

518.5

783. Programmed digital calculators (electronic calculating machines). I. A general survey. H. RUTISHAUSER, A. SPEISER AND E. STIEFEL. *Z. angew Math. Phys.*, **1** (*No.* 5) 277–97 (1950) *In German.*

The characteristic features of electronic calculating machines are described, the history of their development is reviewed and some applications are discussed. The principles of operation are outlined in general terms. A comprehensive list of all machines known to be operating or under construction at the end of 1949 is given; this includes information on capacity, method of operation and speed. A bibliography of 67 references is appended. A. SCHOFIELD

518.5

784. Photoelectric instrument for calculating correlation coefficients and for other computations. C. BERNASCONI. *Geofis. Pura. Appl.*, **17**, 40–5 (*July–Sept.*, 1950) *In Italian.*

A device which, being fit for computation of double integrals, and for squaring a great number of functions of function, is suitable to determine the correlation coefficient. A.

518.5

785. The relations between symbolic logic and large scale calculating machines. E. C. BERKELEY. *Science*, **112**, 395–9 (*Oct.* 6, 1950).

Indicates content of symbolic logic. Describes certain parts of a typical computing programme as logical, not arithmetic. S. MICHAELSON

518.5 : 517.9

786. On the solution of ordinary differential equations with digital computing machines. C.-E. FRÖBERG. *K. Fysiogr. Sällsk. Lund, Förh.*, **20** (*No.* 11) 17 *pp.* (1950).

A preliminary treatment of some of the questions arising in planning and coding. The machine is assumed to be electronic with arithmetic and control units and a high-speed inner memory employing the 1-address code. Assuming that the integrand and the integration limits are produced by the machine, a procedure is outlined for instructing the machine to choose the optimum interval length (determined with respect to the numerical integration error). Integration of $y' = f(x, y)$ by Kutta's method is set out with note on equations of higher order. The problem arising from a non-linear equation with many-point non-linear boundary conditions is treated by the trial and error method, which, though more laborious, is sometimes the only possibility. A. J. KENNEDY

518.5 : 548.735.4

A machine for synthesizing two-dimensional Fourier series in the determination of crystal structures. *See Abstr.* 1496

518.5 : 621.317.757

787. On the periodic analysis of curves. C. BERNASCONI. *Geofis. Pura. Appl.*, **16**, 181–7 (*April–June*, 1950) *In Italian.*

A method, with an example, for the quick determination of the selective combinations used in periodic analysis is described. An optical and photoelectric harmonic analysing device which can be used for the methods of Labrouste and Vercelli is described in some detail, together with a modification in the construction of Lovera's electric analyser. [See Abstr. 12 (1949)]. S. WEINTROUB

519.2 : 621.3.015.2

788. On a first-passage-time problem. F. L. H. M. STUMPERS. *Philips Res. Rep.*, **5**, 270–81 (*Aug.*, 1950).

In this fluctuation problem the probability is required that a function starting at a time $t = 0$ with a value E_0 will not have exceeded a value E_1 in the time interval $(0, t_1)$. This probability is calculated (*a*) from the Fokker–Planck equation with suitable boundary conditions, and (*b*) from an integral-equation derived by Schrödinger. A.

519.27

789. Estimation of the error at a point on a least squares curve. P. G. GUEST. *Aust. J. Sci. Res. A*, **3**, 173–82 (*June*, 1950).

The estimation of the errors in the values obtained by fitting a least-squares polynomial to a number of equally-spaced observations of a variable quantity is discussed. Curves and tables of the weight function are obtained. A

519.27

790. Estimation of heterogeneous error variances. A. S. C. EHRENBERG. Letter in *Nature, Lond.*, **166**, 608 (*Oct.* 7, 1950).

519.283 : 530.162 : 621.38 : 621.395.64

791. Some statistical models useful in the study of noise. A. BLANC-LAPIERRE. *C.R. Acad. Sci., Paris*, **231**, 566–7 (*Sept.* 18, 1950) *In French.*

A result is given concerning the spectral decomposition of the response of an amplifier to a sequence of impulses which occur at random intervals following a Poisson distribution. The correlation function is also given; the density of the impulses may be constant or may be given by a Fourier series. L. S. GODDARD

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522.6 : 621.396.9

792. The use of radio waves for astronomical observations. J. L. PAWSEY. *Aust. J. Sci.*, **12**, 5–12 (*Aug.*, 1949).

A review article summarizing work on galactic noise, solar noise, radio stars, the radio measurement of lunar temperatures, and lunar and meteor radar echoes. A. C. CLARKE

522.6 : 621.398

793. Sun follower for V-2 rockets. H. L. CLARK. *Electronics*, **23**, 71–3 (*Oct.*, 1950).

Describes an automatic tracking device for keeping a spectrograph pointed at the sun despite rocket spins of up to 50 r.p.m. and precession through angles of up to 40 degrees with the vertical. Two-axis stabilization, accurate to ½ degree, is achieved by error signals derived from the sun, whose image falls on a rotating shutter with spoke and wedge shading. The resulting photocell signal (400 c/s carrier with 40 c/s modulation) is compared with reference signals and the error voltages control elevation and azimuth servo-motors. The device is fitted with automatic search in azimuth, and also provides rocket-aspect data for telemetering. It permits measurement of radiation down to 500 Å. A. C. CLARKE

523.16 : 532.5

794. Hydrodynamical problems relating to masses of cosmic dimensions. L. ZAPPA. *Mem. Soc. Astron. Ital.*, **21** (*No.* 2–3) 149–57 (1950) *In Italian.*

The author reviews briefly recent researches in cosmical hydrodynamics, such as the expansion and collision of interstellar clouds (Burgers, McVittie), their composition (Adams), the heating of the solar chromosphere and corona, discussed in 1949 at the "Symposium on hydrodynamical problems concerning masses of cosmical dimensions" held in Paris [Schwarzschild's theory of the heating of the corona by acoustic waves referred to on p. 153, has since been shown invalid by T. Gold [Abstr. 3732 (1949)]. V. C. A. FERRARO

523.16

795. The acceleration of dust grains by supernovae. B. WOLFE, P. MC. R. ROUTLY, A. S. WIGHTMAN AND L. SPITZER, JR. Letter in *Phys. Rev.*, **79**, 1020–1 (*Sept.* 15, 1950).

The assumptions of Spitzer's paper [*Phys. Rev.* **76**, 583 (*Aug.* 15, 1949)] are critically examined. The corrections necessary are in general such as to reduce the maximum grain velocities, and make it unlikely that the proposed mechanism can produce the observed heavy cosmic-ray particles. M. W. OVENDEN

523.165

796. Galactic radiation at radio frequencies. I. 100 Mc/s survey. J. G. BOLTON AND K. C. WESTFOLD. *Aust. J. Sci. Res. A*, **3**, 19–33 (*March*, 1950).

An account of a survey of galactic radiation at a frequency of 100 Mc/s. An aerial array with a 17° beamwidth, on an equatorial mounting, was used to plot the distribution of intensity over the section of the celestial sphere between Declination + 30° and − 90°. The method of eliminating the effect of the aerial polar diagram from the observations is described and the final distribution, expressed in terms of equivalent black-body temperature, is presented in galactic co-ordinates on a series of equal-area charts. A

523.165

797. Galactic radiation at radio frequencies. II. The discrete sources. G. J. STANLEY AND O. B. SLEE. *Aust. J. Sci. Res. A*, **3**, 234–50 (*June*, 1950).

An account is given of observations on a number of discrete sources of r.f. radiation, together with a

brief description of the observational techniques used in their detection, and of the methods employed to determine their positions and angular extent. Noise spectra of 4 of the more intense sources have been measured over a frequency range of 40–160 Mc/s: in 3 cases the change of intensity with wavelength is found to be greater than that of the background continuum, and in 1 case less. Two of the sources have been provisionally identified with astronomically rare objects, the Crab Nebula and N.G.C. 5128. Finally, the short period fluctuations in the intensity of some of the sources, notably that in Cygnus, are discussed. Evidence is presented which, contrary to previous views, suggests that these fluctuations are of terrestrial rather than of extra-terrestrial origin. A.

523.165

798. Galactic radiation at radio frequencies. III. Galactic structure. J. G. BOLTON AND K. C. WESTFOLD. *Aust. J. Sci. Res. A*, **3**, 251–64 (*June*, 1950).

From r.f. observations it is deduced that the sun is situated in or near an arm of a spiral galaxy. The first part of this paper consists of an analysis of the r.f. data followed by the presentation of optical evidence in favour of a spiral form. The sense of rotation of the Galaxy—that of the spiral unwinding—is in accordance with the theories of Lindblad and Milne. A.

523.165

799. Survey of galactic radio-noise at 200 Mc/s. C. W. ALLEN AND C. S. GUM. *Aust. J. Sci. Res. A*, **3**, 224–33 (*June*, 1950).

A survey of galactic radio-noise at 200 Mc/s has been made for the region of the sky south of declination 45°N. Results are expressed graphically in watts m^{-2} $(c/s)^{-1}$ $(steradian)^{-1}$, the maximum value being 20×10^{-21} W m^{-2} $(c/s)^{-1}$ $(steradian)^{-1}$ at galactic latitude $-3°$ and longitude 322°. Corrections have been made for the aerial beam width. No measurement has been made of the residual intensity from the coldest parts of the sky (the galactic poles) and this quantity, when known, should be added to the results quoted. The galactic noise provides a permanent and convenient standard for solar noise measurements, and its intensity for this purpose is evaluated. A.

523.165

800. On the possibility of determining the distance of the "point" sources of galactic radiation. I. S. SHKLOVSKIĬ. *Dokl. Akad. Nauk, SSSR*, **73** (*No.* 3) 479–81 (1950) *In Russian.*

A method is developed for determining the distances of the "point" sources of galactic radiation founded on analysis of the real fluctuations of intensity on different wavelengths. L. J. GOODLET

523.3 : 538.566 : 551.510.535

801. Certain physical constants and their relation to the Doppler shift in radio echoes from the moon. A. B. THOMAS. *Aust. J. Sci.*, **11**, 187–92 (*June*, 1949).

The factors discussed are the rotation of the earth and the moon's radial motion. These are related to the radius of the earth, the deflection of the vertical, and the moon's motion. It is found, however, that these cannot be independently determined from the Doppler shift of lunar echoes owing to the effects of the ionosphere. A. C. CLARKE

523.53

802. Bečvář's meteor stream, 1949. G. S. HAWKINS AND M. ALMOND. *J. Brit. Astron. Ass.*, **60**, 251–6 (*Oct.*, 1950).

Radar observations are reported, and the relationship between the present activity in this radiant, the intense shower of Bečvář observed in 1945, and Comet Tuttle discussed. M. W. OVENDEN

523.72

803. Measurements of solar radiation at a wavelength of 50 centimetres during the eclipse of November 1, 1948. W. N. CHRISTIANSEN, D. E. YABSLEY AND B. Y. MILLS. *Aust. J. Sci. Res. A*, **2**, 506–23 (*Dec.*, 1949).

Abrupt changes of slope in the plot of received flux against duration of eclipse are interpreted as due to covering or uncovering of discrete areas of activity on the solar surface, and these areas were found associated with visible sunspots, positions previously occupied by sunspots and prominences. The general distribution of radiation over the solar disk, after allowing for the centres of activity, was consistent with a theoretical distribution involving limb brightening, about 40% of the total radiation originating outside the visible limb of the sun. No polarization changes which could be associated with a general solar magnetic field were observed. M. W. OVENDEN

523.72

804. Solar radiation at a wavelength of 10 centimetres, including eclipse observations. J. H. PIDDINGTON AND J. V. HINDMAN. *Aust. J. Sci. Res. A*, **2**, 524–38 (*Dec.*, 1949).

The distribution of radiation over the solar disk was determined, the most intense radiation coming from near the limb and some radiation from outside the visible disk. At least one discrete area of high intensity was found, and polarization observations suggest that the radiation from this area was partially circularly polarized. General polarization measurements were inconclusive, but definitely inconsistent with a general magnetic field of the sun with intensity as great as 50 gauss at the poles. M. W. OVENDEN

523.72

805. Solar radiation of wavelength 1·25 centimetres. J. H. PIDDINGTON AND H. C. MINNETT. *Aust. J. Sci. Res. A*, **2**, 539–49 (*Dec.*, 1949).

The mean intensity observed over a period of six months corresponds to a black-body temperature of $1{\cdot}00\times10^4$ °K, ± 5%. Day-to-day variations were less than the observational limit of ± 3%, and even during periods of intense solar activity the short-period fluctuations did not exceed ± 5%. An interferometric method of determining the distribution of intensity across the solar disk gave results consistent with 84% from a uniform disk and 16% from a narrow circumferential ring. M. W. OVENDEN

523.72

806. Radio-frequency radiation from the quiet sun. S. F. SMERD. *Aust. J. Sci. Res. A*, **3**, 34–59 (*March*, 1950).

The equation of transfer of radiation is used in a ray treatment of r.f. radiation from the solar atmosphere in the absence of solar activity. The intensity distribution across the solar disk is shown to depend

significantly on the coronal temperature. Both limb-brightening and limb-darkening can occur but are appreciable only when the corona is optically thin, yet not transparent. A measure of the size of the radio-frequency disk is obtained in terms of the size of the optical disk. The apparent temperature (an equivalent measure of the flux density at the earth) is found to reach a maximum as a function of frequency for each coronal temperature and as a function of coronal temperature for each frequency. Within the limits of experimental error all observed apparent temperatures fall within the range of theoretical values corresponding to chromospheric temperatures from 10^4 to 3×10^4 °K and coronal temperatures from $2{\cdot}5\times10^5$ to 3×10^6 °K. The effects of a possible general magnetic field of the sun are estimated in selected cases and found to be small in relation to those due to the uncertainties in the temperature of the solar atmosphere. A.

523.72

807. Solar radiation at a wavelength of 3·18 centimetres. H. C. MINNETT AND N. R. LABRUM. *Aust. J. Sci. Res. A*, **3**, 60–71 (*March*, 1950).

This has been measured over a period of three months. The received intensity was found to vary from day to day and the changes are shown to be closely associated with sunspots. The equivalent black-body temperature of the sun over this period, in the absence of sunspots, was 19 300°K, with a probable error of ± 7%. The temperature increased by 8°K per unit increase of sunspot area (one unit equals 10^{-5} times the area of the sun's visible disk). This increase is much less than that at longer microwavelengths. Sudden increases of radiation at 3·18 cm, caused by disturbed conditions in the sun, were found to be rare. A number of bursts were observed and a comparison is made with records of longer wave solar radiation and other phenomena of solar origin. Observations were made during the solar eclipse of November 1, 1948, and the results are consistent with either of two simple brightness distributions on the sun's disk. A.

523.72

808. The polarization of thermal "solar noise" and a determination of the sun's general magnetic field. S. F. SMERD. *Aust. J. Sci. Res. A*, **3**, 265–73 (*June*, 1950).

The equation of transfer of radiation and the magneto-ionic theory are used to derive expressions for the degree of polarization of thermal "solar noise" due to a general magnetic field of the sun. In particular, the net polarization of 600 Mc/s (50 cm) radiation corresponding to the maximum phase of the eclipse of November 1, 1948, as seen from Melbourne, Victoria, is evaluated theoretically and compared with observational evidence. This leads to an upper limit of 11 gauss for the surface field-strength at the solar poles at the time of observation. A.

523.72

809. A correction. "Solar radiation at 1 200 Mc/s., 600 Mc/s., and 200 Mc/s." F. J. LEHANY AND D. E. YABSLEY. *Aust. J. Sci. Res. A*, **3**, 350 (*June*, 1950).

See Abstr. 1394 (1950). Correction also applies to Abstr. 2868 (1950).

523.74

810. Brightness fluctuations of the granulation o the sun. G. THIESSEN. *Naturwissenschaften*, 3 (*No.* 18) 427 (1950) *In German.*

The contrast of the granulation of the sun wa determined visually by means of a 60 cm refracto used at full aperture, comparing the granulation wit a range of model granulations of different contrast and sizes of the granules which were prepared photo graphically. At an effective wavelength of 5 650 the average intensity difference between the granule and the background was 25%, the size of the granule being 1·3 sec of arc approx. The intensity differenc corresponds to a temperature difference of 300 [probably °C]. W. F. BERC

523.74

811. On the present position in the interpretation o the sunspot phenomena. W. GROTRIAN. *Z. angew Phys.*, **2** (*No.* 9) 376–90 (1950) *In German.*

A brief summary of the observed characteristic and behaviour of sunspots is followed by a critica account of the theories of Bjerknes, Alfvén, Walé and others. The possible relationship between th observed static and variable stellar magnetic field with the sunspot phenomenon is discussed, togethe with possible explanations of these variable fields Recent attempts to measure the intensity of a genera solar magnetic field are examined. M. W. OVENDE

523.7

812. Investigation of fluctuations in the luminescenc of solar prominences. A. B. SEVERNYĬ. *Dokl. Akad Nauk, SSSR*, 73 (*No.* 3) 475–8 (1950) *In Russian.*

Experimental measurements are described mad with a specially-constructed narrow-band polarizing interferometer and coronograph to determine the time relationship of the relative brightness of luminescenc of solar prominences and the similar relationship o the fading time to the dimension l of characteristi nodes moving nearly perpendicularly to the visual ray The results appear to indicate in particular that th luminescence of the prominences is caused by heating from the corona. The origin of the phenomenon however, still requires detailed investigation, although the impression is already obtained that the process i one of adiabatic expansion and hypercooling of H projected from the interior of the body into the incandescent plasma of the solar corona. L. J. GOODLE

523.7

813. The value of observations of continuous spectra in the chromosphere and prominences. H. ZANSTRA *Proc. K. Ned. Akad. Wet.*, **53** (*No.* 8) 1289–99 (1950)

The intensity of the continuous spectrum for various wavelengths to be expected in the chromosphere and in prominences is computed for electron temperatures of 5 000°, 10 000°, 20 000° and 30 000° and electron or proton concentrations of the order 10^{11} (chromosphere) and 10^{10} (prominences). The result may serve as a guide for future eclipse observations. It is pointed out that present evidence points to a chromospheric electron temperature a good deal lower than Redman's kinetic temperature of about 30 000° fo atoms and ions. The spectra considered are the *Ba* spectrum, the other recombination and electron switch spectra indicated by *C* and that by scattering o

photospheric light by free electrons marked c. For the chromosphere the determination of electron or proton concentration as well as of electron temperature appears possible. For prominences one can determine concentration and thickness, provided the electron temperature be known. A remark concerning the possible influence of the continuous spectrum due to the formation of negative H ions is made. A.

523.77

814. Improved map of the solar spectrum between 9 and 10 μ. J. H. SHAW, R. M. CHAPMAN AND J. N. HOWARD. Letter in *Phys. Rev.*, **79**, 1017–18 (*Sept.* 15, 1950).

523.821.3

815. On the possible existence of some non-homogeneities in the international photographic magnitude scale for brighter stars. T. ADOLFSSON. *Ark. Astron.*, **1**, *Paper* 15, 175–86 (1950).

Comparisons between monochromatic magnitudes based on grating exposures and magnitudes on the international photographic scale have given the same differences as found before between photoelectric and photographic magnitudes. Several confirmations as to a break in the photographic scale between magnitudes 8–9 are given. It seems as if 1·00 magnitude in a homogeneous magnitude scale corresponds, in the interval 6–8, to only about 0·93–0·94 magn. and, in the interval 9–11 to 1·02–1·03 magn. in the internationally adopted scale. Also in the case of stars brighter than the 6th magn. there seem to be non-homogeneities in the photographic scale. A.

523.821.5

816. Some preliminary results of photoelectric determinations of colours and magnitudes in double stars. Å. WALLENQUIST. *Ark. Astron.*, **1**, *Paper* 17, 193–8 (1950).

Describes experiments using a multiplier phototube attached to the 13-inch photographic refractor at Upsala to measure colours and magnitude differences in double stars. Using blue and yellow filters, extra focal images were measured by the photocell. Experiments with large and small diaphragms were made. From the small number of results secured, a probable error of ± 0·022 mag. is derived indicating that in this kind of work the higher accuracy of single star photoelectric photometry is unlikely to be attained.

E. G. MARTIN

523.872

817. Colour temperatures of B-stars. J.-C. PECKER. *C.R. Acad. Sci., Paris*, **231**, 821–3 (*Oct.* 23, 1950) *In French.*

Low colour temperatures (T_c), observed for early type stars, B0–B2, in relation to their effective temperatures, has been explained either by abnormal superexcitation in the stellar atmosphere; or by interstellar reddening affecting the different types unequally owing to a selective distribution in the galaxy. It is here shown that, by the choice of suitable stellar models, based on H and He atmospheres, accepted theoretical premises lead to computed values in close agreement with the observed T_c.

D. R. BARBER

523.877

818. A variational solution of a perturbation problem in the theory of stellar structure. A. REIZ. *Ark. Astron.*, **1**, *Paper* 16, 187–91 (1950).

The linear differential equation obtained previously [Abstr. 3580 (1948)] is expressed as the Euler equation of a variational integral, and the classical Rayleigh–Ritz procedure is employed. Calculations are made for an approximation function consisting of a single term. The resulting mean value of $\kappa\eta$ differs from the more accurate value obtained by detailed integration by about 5%. R. A. NEWING

523.877

819. The calculation of a model of a turbulent stellar atmosphere. M. BAROIN AND E. SCHATZMAN. *C.R. Acad. Sci., Paris*, **231**, 757–8 (*Oct.* 16, 1950) *In French.*

A table gives the results of the calculation of conditions within a model supergiant atmosphere (similar to η Aquilae, type CG4) in which the propagation of shock waves of large amplitude produces macro-turbulence. Under these conditions, a minimum temperature is found for an optical depth $\tau = 0{\cdot}02$. High turbulent velocities ($\sim$ 40 km/sec) are found to be confined to a layer of small optical thickness above the photosphere proper, velocities in the photosphere not exceeding 10 km/sec. These results agree with curve-of-growth analyses of supergiant atmospheres, in particular that of δ Canis Majoris. [Abstr. 2167 (1950)]. M. W. OVENDEN

525.35 : 550.3

820. Indications of correspondences between geophysical phenomena and motion of the pole. T. NICOLINI. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **8**, 599–605 (*June*, 1950) *In Italian.*

There appears to be no indication of a possible correlation between geophysical or meteorological variations and the Chandlerian cycle. The evidence is that the Chandlerian cycle is due to mechanical and not geophysical causes. Conversely [see Abstr. 7722 (1950)], irregular perturbations in the Chandlerian cycle appear to be connected with geophysical perturbations. V. C. A. FERRARO

525.61

821. Phase differences between theoretical and observed tides. H. VOIT. *Geofis. Pura. Appl.*, **17**, 37–9 (*July–Sept.*, 1950) *In German.*

An influence of the velocity of gravitation on the tides could not be detected. Phase differences between observed and theoretical tides (κ) may only be related to the local elastic behaviour of the earth crust and the tidal friction. Peculiarly big values of κ are often observed, but greater accuracy of measurement and a more thorough elimination of disturbing influences will be required to account for them. Under certain circumstances it would seem possible to reduce the average phase deviations to ± 0·7 min with regard to the half-day terms M_2 and S_2. A.

526.954.9 : 621.396.9

822. Levelling by radar altimeter. S. JOWITT. *Engng J., Montreal*, **33**, 689–94 (*Aug.*, 1950).

The characteristics of a continuous-recording radar altimeter, developed in Canada, are described. The equipment working on 3·2 cm and with a very sharp radiation pattern has been used (1949) for surveying

large tracts of wild country in Canada, and works by the difference in heights indicated by a barometer (above sea level) and the radar altimeter (true height).

C. A. HOGARTH

529.78

823. Chronograph recording to 1 millisecond. G. MASSON. *Ann. Franç. Chronom.*, **4** (*No.* 3) 275–84 (1950) *In French.*

The time of opening or closing an electrical circuit is recorded on a moving paper to 1 millisecond. A 1 000 c/s frequency standard drives a motor with contacts which operate mechanical counters giving the time in minutes, seconds and tenths of a second. The next two figures are obtained by an electronic counter which is set in operation by the 0·1 s contact of the motor. The counter is stopped by the exciting impulse, permitting the count to be recorded on the paper strip. Three observations per second can be made.

L. ESSEN

PHYSICS 53

53.081.4 : 538.3

Equations with 3, 4 and 5 fundamental quantities in electrodynamics. *See Abstr.* 514

53.081.6

824. The universal constants. I–II. A. CARRELLI. *Scientia*, **85** (*No.* 8–9) 189–94; (*No.* 10) 233–40 (1950) *In Italian.*

The concept of universal constant and the various constants, including the velocity of light, Planck's constant, the gravitational constant, the elementary electric charge and Einstein's cosmological constant are briefly explained and discussed. Reference is also made to the various elementary particles.

S. WEINTROUB

FUNDAMENTALS 530.1

530.12

825. On the influence of the metric field on a scalar matter-field. W. SCHERRER. *Helv. Phys. Acta.*, **23** (*No.* 5) 547–55 (1950) *In German.*

Static, spherically symmetric solutions of field equations derived from a proposed action density

$$\left[(R - 2\Lambda)\psi^2 + 4\omega g^{\rho\sigma}\frac{\partial\psi}{\partial x^\rho}\frac{\partial\psi}{\partial x^\sigma}\right]\sqrt{-g}$$

are obtained for $\Lambda = 0$, $\omega \neq 0$. Their formal structure is similar to the case $\Lambda = 0$, $\omega = 0$ [Abstr. 1454 (1950)]; however, the resultant field distribution may differ greatly.

R. H. DALITZ

530.12

826. Unitary affine theory. I. Choice of basic tensors and derivation of the fundamental equation. M.-A. TONNELAT. *C.R. Acad. Sci., Paris*, **231**, 470–2 (*Aug.* 21, 1950) *In French.*

See Abstr. 2945 (1949). By a suitable restriction on the affine connection Δ a relation is obtained similar to the equation $\omega : \rho = 0$ of Einstein (*The meaning of relativity*, 1950), and leading to the same fundamental equation.

G. J. KYNCH

530.12

827. Unitary affine theory. II. Rigorous solution of the fundamental equation. M.-A. TONNELAT. *C.R. Acad. Sci., Paris*, **231**, 487–9 (*Aug.* 28, 1950) *In French.*

See preceding Abstr. The basic tensor of the author's theory is separated into symmetric and anti-symmetric parts, and solutions are obtained for these components separately.

E. P. GEORGE

530.1

828. Unitary affine theory. III. Field equations. M.-A. TONNELAT. *C.R. Acad. Sci., Paris*, **231**, 512–14 (*Sept.* 4, 1950) *In French.*

530.12 : 538.

829. On the gravitational energy of the matter-free electromagnetic field. K. V. LAURIKAINEN. *Ann. Acad. Sci. Fennicae, Ser. A.I, No.* 68, 7–44 (1950) *In German.*

Previous expositions of the problem are critically examined, including the introduction of the pseudo-tensor of gravitational energy, and the method of calculating the first approx. to the solution. To avoid the divergences obtained by Rosenfeld [*Z. Phys.*, **65**, 589 (1930)] the equations are then solved using the Reisz method of analytic continuation. Difficulties with divergences are still encountered, but they are avoided in the equivalent formalism of Pauli which gives a finite gravitational energy.

G. J. KYNCH

530.12 : 538.312

830. On Minkowski's electrodynamics of moving bodies. M. VON LAUE. *Z. Phys.*, **128** (*No.* 3) 387–94 (1950) *In German.*

The energy momentum tensor should be such that the velocity of energy propagation in a plane wave satisfies the relativistic law for the composition of velocities. Minkowski's unsymmetrical tensor for the field in a moving body is found to be the only one satisfying this requirement, and is therefore regarded as correct; the momentum density vector is then, in general, not parallel to the energy flow vector.

R. A. NEWING

530.14

831. On the process of association of elementary particles. I. I. PLACINTEANU. *Atti Accad. Naz. Lincei (R.C. Cl. Sci. Fis. Mat. Nat.)* **8**, 587–92 (*June*, 1950) *In French.*

The author postulates that, in the process of association of two particles whose distance and masses vary adiabatically, the following laws hold, besides conservation of energy and of momentum: (*a*) the ratio between the distance and the reduced mass remains constant; (*b*) the angular velocities of proper rotations and of the rotation about the centre of mass become equal. Applications are given.

L. PINCHERLE

530.145

832. The paradox of separated systems in quantum theory. J. L. B. COOPER. *Proc. Camb. Phil. Soc.*, **46** (*Pt* 4) 620–5 (1950).

The paradox is, that after two interacting systems 1

and 2 have separated, the state of 2 seems to be determined by a measurement on 1; e.g. that by a choice of measurement on 1 the system 2 may be put into a state where position is exactly known or one where the momentum is exactly known. These arguments break down either because systems cannot be completely separated or because, if separated, they no longer have self-adjoint representations for momenta. G. J. KYNCH

530.145

833. Researches on the foundations of the quantum calculus of probabilities in the pure case (Hilbert space, wave principle). G. BODIOU. *Ann. Phys., Paris*, **5**, 451–536 (*July–Aug.*, 1950) *In French.*

A criticism of the current method of introducing probabilities into quantum mechanics is followed by the introduction of a stochastic relation between the values of two measurements of a variable, in place of the usual logical disjunction of the two. In the case of momentum and co-ordinate the dependence is that of a Fourier transformation to go from one representation to the other if it is assumed that their probabilities can be of a Gaussian form simultaneously and without correlation. This is justified by an appeal to the correspondence with classical mechanics, and leads naturally to the uncertainty principle and the introduction of Planck's constant. G. J. KYNCH

530.145

834. Variation principle and conservation equations in non-local field theory. G. BLOCH. *K. Danske Vidensk. Selsk. Mat.-fys. Medd.*, **26** (*No.* 1) 5–30 (1950).

An interpretation of the non-local fields introduced by H. Yukawa is given by means of a rule associating any non-local quantity with a corresponding density, which is an ordinary function of space and time. It is shown that, in the spirit of this interpretation, the field equations can be deduced from a variation principle. Conservation equations follow from the invariance properties of the Lagrange function. It appears that a collision process has to be regarded as a whole in accordance with the ideas of the *S*-matrix theory. Application is made of these principles to the free fields of spin 0 and $\frac{1}{2}$, and the second quantization is introduced. It is shown in particular that, with the proposed interpretation, no physical meaning can be attached to the solutions of the field equations with "internal rotation" described by H. Yukawa. A Lorentz-invariant supplementary equation excluding these extra solutions is established. A.

530.145

835. On the quantum theory of elementary particles. W. HEISENBERG. *Z. Naturforsch.*, **5a**, 251–9 (*May*, 1950) *In German.*

A consistent field theory leading to a scheme of elementary particles may be constructed within the frame of existing field theories. The totality of all particles is represented by a single spinor field $\psi(x)$ satisfying, in interaction representation, the regular commutation relation $[\psi_\alpha(x), \psi_\beta(x')] = -iS^R_{\alpha\beta}(x-x')$, S^R being the usual *S*-function regularized by function $\rho(\kappa)$. Covariant expressions are given for the energy-momentum tensor and current vector of this field. Choice of $\rho(\kappa)$ and of a covariant interaction energy $H(x)$ of fourth degree in ψ, $\bar{\psi}$ (e.g. such as $A\bar{\psi}\gamma^\mu\psi\ \bar{\psi}\gamma_\mu\psi$) completely specifies the theory. The interaction is thus "strong" or "weak" according as $A \gtrless l^2$, l being a certain fundamental length. Self-energies are then finite in second order, but are not proportional to the mass of the zero-order state. For strong coupling, closely bound states of binding energy comparable with the constituent masses may represent other fundamental particles of integral or half-integral spin—the distinction between elementary and complex particles then becomes arbitrary. Avoidance of negative energy difficulties requires the use of an indefinite metric, so that $H(x)$ is no longer Hermitian. The ansatz $S = T(T^*T)^{-\frac{1}{2}}$ is then suggested for the corresponding *S*-matrix, T being formally the Dyson *S*-matrix series evaluated for non-Hermitian $H(x)$. R. H. DALITZ

530.145

836. Quantum effects in the interaction of electrons with high frequency fields. J. C. WARD. Letter in *Phys. Rev.*, **80**, 119 (*Oct.* 1, 1950).

530.145 : 538.1

837. Quantum electrodynamic self-energy and the exact solution of the Schrödinger equation. I. H. SALECKER. *Z. Naturforsch.*, **5a**, 431–8 (*Aug.*, 1950) *In German.*

Following a discussion of the role of degeneracy in this problem and the attempts made to overcome it, the reasons for believing that the divergences lie in the formalism rather than in the mathematical methods of solution. G. J. KYNCH

530.145

838. On a new form of the theory of the "subtracted field." L. DE BROGLIE. *J. Phys. Radium*, **11**, 481–9 (*Aug.–Sept.*, 1950) *In French.*

Previous work [Abstr. 2920 (1950)] is continued, especially on the interaction of a particle of spin $\frac{1}{2}$ with a number of fields. It is stated that an application of Feynmann's methods leads to a small correction to the mass of the electron. G. J. KYNCH

530.145

839. On the influence of the spin interaction on the scattering of mesons and electrons by light nuclei. E. AMALDI, G. FIDECARO AND F. MARIANI. *Nuovo Cim.*, **7**, 757–73 (*Sept.*, 1950).

As an extension of a preceding paper [Abstr. 639–40 (1951)], the electromagnetic collision of a particle of a spin $\frac{1}{2}$ against a light nucleus, represented as a "one-particle model," is treated in the first Born approximation. The differential cross-sections for coherent as well as for incoherent scattering against Li and C nuclei are calculated for μ-mesons of 200 and 600 MeV and for electrons of 300 MeV; the new results are compared with those obtained in the preceding paper neglecting the spin of the impinging particle. As a conclusion a short discussion is given of the contribution of the neutrons, present in the nucleus, to the electromagnetic scattering, in which the finite dimensions of the observed nucleons are taken into account. A.

530.145

840. Reactions between nucleons and mesons, and the search for negative protons. L. MICHEL. Letter in *Nature, Lond.*, **166**, 654–5 (*Oct.* 14, 1950).

The concept of "classes of reactions" [Abstr. 5516

(1950)] is used to prove that the suggestion that negative protons may be emitted from β^- radioactive nuclei which emit a delayed neutron is unfounded.

W. J. SWIATECKI

530.145

841. On the theory of the scattering of particles of spin ħ/2. G. PETIAU. *C.R. Acad. Sci., Paris*, **231**, 825–7 (*Oct.* 23, 1950) *In French.*

Calculation of the mutual scattering cross-sections of particles due to their interaction with the same field of meson-type (spin 0 or 1). J. R. MADDOX

530.145

842. Radiative corrections in the non-relativistic limit. W. THIRRING. *Phil. Mag.*, **41**, 1193–4 (*Nov.*, 1950).

It is known by direct calculation that these vanish in 2nd- and 4th-order using Dyson's renormalization procedure. It is shown that it holds in all approximations. G. J. KYNCH

530.145

843. Study of spinor fields and their quantization. J. GÉHÉNIAU. *Mem. Acad. Roy. Belge. Cl. Sci.*, **21** (*No.* 5) 3–56 (1948) *In French.*

The derivation and properties of spinor fields of arbitrary order and type in Minkowski space are developed systematically, together with those of the matrices associated with them. The results allow quantization of the theory, and commutation rules are explicitly obtained. There is a short discussion on a method of extending the results to general relativity. G. J. KYNCH

530.145

844. On time-independent integrals of motion of the one-body problem in Dirac theory. A. W. SÁENZ. Letter in *Phys. Rev.*, **79**, 1004–5 (*Sept.* 15, 1950).

Two theorems are stated concerning the form of dynamical operators which commute with the Hamiltonian of Dirac electron theory, one valid for a general four-potential field, the other relevant to a symmetrical static potential. R. H. DALITZ

530.145

845. Geometric demonstration of the tensor equations of the photon: the complexity of the particle of spin 1. G. BODIOU. *C.R. Acad. Sci., Paris*, **231**, 568–70 (*Sept.* 18, 1950) *In French.*

From a consideration of the invariance properties of a product of spinors the wave equations are interpreted as geometric conditions imposed on the wave matrix. G. J. KYNCH

530.145

846. Coherent scattering of light by an atom and negative energy states. K. J. LE COUTEUR AND S. ZIENAU. *Proc. Phys. Soc. Lond. A*, **63**, 1223–6 (*Nov.*, 1950).

It is proved that the difference between the single electron theory and the positron theory for the coherent scattering of light by an atom represents the scattering of light by the atomic potential. In the practical cases the effect is negligible. The gauge invariance of the perturbation formulae for this effect is discussed. A.

530.145 : 530.12

847. The Hamiltonian of the general theory of relativity with electromagnetic field. P. G. BERGMANN, R. PENFIELD, R. SCHILLER AND H. ZATZKIS. *Phys. Rev.*, **80**, 81–8 (*Oct.* 1, 1950).

A specific example is given of a Hamiltonian of a non-linear field theory, a Hamiltonian density completely free of time derivatives. In accordance with the general theory developed previously, this Hamiltonian is one of the constraints between the canonical variables and, therefore, vanishes everywhere. To obtain this function, methods have been developed that will also permit the construction of Hamiltonian densities in any field theory in which the Lagrangian density is quadratic in the first derivatives. This Hamiltonian differs from the one obtained by Schild and Pirani in that they use Dirac's method to derive a Hamiltonian that is invariant but contains velocities, so that their canonical field equations cannot be solved with respect to the time derivatives of all canonical variables. In the formalism used here, the canonical equations contain no time derivatives on the right-hand sides, but the adoption of a particular Hamiltonian is equivalent to the adoption of a particular coordinate condition and gauge condition. However, once any one Hamiltonian density has been obtained, any other one can readily be obtained (arbitrary coordinate and gauge conditions resulting) by combination with the other constraints of the theory in question. A.

530.145 : 539.18

848. Magnetic moments of elementary particles with higher spin. A.-W. MAUE. *Z. Phys.*, **128** (*No.* 3) 378–86 (1950) *In German.*

Dirac's wave equation for the electron is generalized by introduction of a numerical factor N. The case $N = 3$ is treated, for which spins $\frac{1}{2}$ and $\frac{3}{2}$ are found and restmasses m and $3\,m$ (m = electronic restmass). Perturbation calculations show that even for a weak magnetic field a superposition of states with spins $\frac{1}{2}$, $\frac{3}{2}$ arises, so that in general a particle with definite spin does not possess a definite magnetic moment.

J. JACOBS

530.145

849. Masses of fundamental particles. R. FÜRTH. *Nature, Lond.*, **166**, 727–8 (*Oct.* 28, 1950).

Prediction in terms of pure numbers, the fine structure constant and a number $k = 15/32$ derived by the author in *Z. Phys.*, **57**, 429 (1929).

W. J. SWIATECKI

530.145

850. Masses of fundamental particles. G. STEPHENSON. Letter in *Nature, Lond.*, **166**, 655–6 (*Oct.* 14, 1950).

Arithmetical relations between the masses of proton, neutron, mesons and neutrino are discussed in the light of various theoretical and empirical formulae. See also Abstr. 7008 (1950).

530.145

851. On a fourth-order meson-equation. W. THIRRING. *Phil. Mag.*, **41**, 653–62 (*July*, 1950).

A meson field theory based on the equation $(\Box^2 - \mu^2)^2\phi = 0$ is developed, using the covariant methods of Schwinger and Feynman. The nuclear forces derived from a scalar coupling to the nucleon field are non-singular. The second-order nucleon self energy is evaluated and is finite in this theory. However, higher-order nucleon self-energy expressions

will diverge, since modification of the meson equation is not sufficient to make finite the meson self-energy. R. H. DALITZ

530.145 : 539.152.1

852. On spin-orbit interactions and nucleon–nucleon scattering. K. M. CASE AND A. PAIS. *Phys. Rev.*, **80**, 203–11 (*Oct.* 15, 1950).

It is shown that one way of explaining the high energy proton–proton scattering data is by means of a spin-orbit coupling introduced into the nuclear interaction. The radial dependence of this coupling should be such that it has a strongly singular behaviour at $r = 0$ and a small tail. It seems feasible to retain the charge independence of nuclear forces for all energies explored so far. A possible connection with Mayer's interpretation of the shell model of heavy nuclei is indicated. A.

530.145

853. The evaluation of the collision matrix. G. C. WICK. *Phys. Rev.*, **80**, 268–72 (*Oct.* 15, 1950).

Dyson's systematic approach to the reduction of the Heisenberg S-matrix into a sum of "graph" terms can be simplified. A notation is introduced and an algebraic theorem is proved, which allow one to handle the reduction problem quite easily and in the same manner for any type of field. A.

530.145 : 539.18

854. The meson as a composite particle. H. M. MOSELEY AND N. ROSEN. *Phys. Rev.*, **80**, 177–81 (*Oct.* 15, 1950).

Calculations are carried out along the lines of the work of Fermi and Yang in which the π-meson is considered as a composite particle formed from a proton and an anti-neutron. On the assumption of a vector interaction it is found that the $^1S_0$ state must be excluded because its energy goes to zero as the interaction goes to zero, while the $^3P_0$ state appears to give an acceptable solution. On the assumption of a tensor interaction it is found that $^1S_0$ and $^3P_0$ solutions both exist, but for opposite signs of the interaction. The tensor interaction must therefore be excluded since it would lead to the formation of a composite particle by a proton and a neutron. Using the vector interaction one finds that the ground state is a $^3P_1$, but that there are other states with $j = 0$, 1 and 2 lying near it, the proximity depending on the interaction range assumed. A.

530.145

855. Singular solutions of the Klein Gordon equation in an external magnetic field. J. GÉHÉNIAU. *C.R. Acad. Sci., Paris*, **231**, 610–12 (*Sept.* 25, 1950) *In French.*

An exact solution is given, for a constant and uniform field, expressed as a series of the monochromatic solutions of the equation. L. PINCHERLE

530.145 : 537.534.74

856. On the determination of the *P–P* interaction from scattering experiments. C.-E. FRÖBERG. Letter in *Phys. Rev.*, **80**, 105 (*Oct.* 1, 1950).

530.145.6

857. Calculations of the matrix elements of the H atom by means of the Laplace transformation. H. KALLMANN AND M. PÄSLER. *Z. Phys.*, **128** (*No.* 3) 347–65 (1950) *In German.*

Laplace transforms, which have been previously used to obtain radial wavefunctions R_{nl} for the H-atom are here used to evaluate integrals of the type $\int R_{nl}R_{n'l'}r^m dr$. G. J. KYNCH

530.162

858. The uncertainty relation. A. GAMBA. Letter in *Nature, Lond.*, **166**, 653–4 (*Oct.* 14, 1950).

Born's proof of the uncertainty relations from the commutation laws is generalized by applying the method to arbitrary real functions of the two observables A, B. It is also shown how to obtain more and more restrictive conditions for $(\Delta A)^2(\Delta B)^2$ by successive generalizations. L. PINCHERLE

530.162

859. A generalization of the uncertainty relations. A. GAMBA. *Atti Accad. Naz. Lincei (R.C. Cl. Sci. Fis. Mat. Nat.)* **8**, 606 (*June*, 1950) *In Italian.*

See Abstr. 858 (1951).

530.162

860. On the foundation of the exclusion principle. E. KEBERLÉ. *Arch. Sci.*, **3** (*No.* 4) 271–87 (1950) *In French.*

In view of suggestions that one should consider as elementary particles only those satisfying the exclusion rule, the author claims that this rule cannot be considered as a fundamental principle, because it violates the principle of correlation between the postulates of statistics and of relativity [see Abstr. 5483 (1950)]. The exclusion rule is rather a consequence of the principle of correlation, and it follows that only elementary particles with vanishing rest mass can be described by symmetric wavefunctions. Thus there exists a relativistic, and by the principle of correlation a statistical, distinction between the particles with vanishing and those with non-vanishing rest mass. L. PINCHERLE

MECHANICAL MEASUREMENTS 531.7

531.717.3 : 620.172.222 : 621.317.39

861. Multichannel measurement of physical effects by confluent pulse technique with particular reference to the analysis of strain. J. G. YATES, D. H. LUCAS AND D. L. JOHNSON. *Instn Elect. Engrs, Paper* 1030, 13 *pp.* [*Early Proof Issue*].

The methods described are applicable to the measurement of physical effects which lead to variable impedances, either resistive or reactive. If a square pulse is applied to an unbalanced bridge of four resistance arms the output pulse is undistorted. Stray reactances lead to transients at the beginning and end of the output pulse; between the transients the pulse has a plateau corresponding to the direct current out of balance. The shape of the output pulse is studied for a variety of bridges having two resistive and two reactive arms, together with stray reactances. Pulses offer advantages over sinusoidal

excitation. A multichannel system for reading 10 resistance strain gauges is described, circuit diagrams of the equipment being given. Each strain gauge is connected to a bridge, the output of the bridges are connected to the detector amplifier in parallel, and the pulses are fed from a pulse generator to each bridge input in turn. The outputs of the 10 channels are presented simultaneously on a c.r.o. A selection of photographic records is reproduced.

W. T. BLACKBAND (R)

531.719 : 526.92

862. Development of an optical radar system for surveying purposes. C. R. HOOVER. *Trans. Amer. Geophys. Un.*, **31**, 518–25 (*Aug.*, 1950).

The system, which measures distances, horizontal angles and vertical angles directly, consists of an optical transmitter which emits microsecond pulses of light and a photosensitive receiver combined to use different annular sections of the same parabolic reflector. Distances are determined by measuring the time required for a pulse of light to travel from the position occupied by the equipment to another station where a retro-reflector is positioned, and back to the equipment. Angles are measured by so restricting the field of view of the receiver portion of the optics that return light from the retro-reflector cannot enter the receiver until an accurate pointing of the equipment has been made. The practical limitations on maximum range, and range and angular accuracies are discussed. A.

531.76 : 778.3

863. A photographic method for displacement/time recording. F. M. BRUCE. *Brit. J. Appl. Phys.*, **1**, 291–3 (*Nov.*, 1950).

Small spherical reflectors attached to or formed upon the surface of a moving body produce a point image of a fixed light source. This image moves with the body to which the reflector is attached, and by recording its motion on a continuous-feed or rotating drum camera, a displacement/time record is obtained in the form of a fine and sharply focused continuous line which is suitable for detailed analysis. Recording may be carried out under normal lighting conditions by this technique. The camera described gives time scales in the range 0 to 315 in/sec. A.

531.792.3

864. A dividing gear for a ruling engine. E. LEIBHARDT. Letter in *J. Opt. Soc. Amer.*, **40**, 623–4 (*Sept.*, 1950).

MECHANICS OF FLUIDS 532

532.133 : 541.182.6

865. Studies of the viscosity and sedimentation of suspensions. I. The viscosity of suspension of spherical particles. S. G. WARD AND R. L. WHITMORE. *Brit. J. Appl. Phys.*, **1**, 286–90 (*Nov.*, 1950).

After a brief review of the relative viscosity/volume concentration relationships which have been suggested for suspensions of smooth spheres, the results of new experimental work on rigidly defined systems of methyl-methacrylate spheres suspended in aqueous solutions are described and discussed. It is shown that, although their relative viscosity is independent both of the viscosity of the suspending liquid and the absolute size of the spheres at a given concentration it is a function of their size distribution, decreasing with increasing size range to a constant value. The proportionality constant between specific viscosity and volume concentration at infinite dilution varies from about 4·0 for a size ratio of 1 : 1 to 1·9 for ratios exceeding 3 : 1. When the suspensions consist of dielectric particles in a non-polar liquid, electrostatic charging of the particles may affect the measured viscosity. A

532.51

866. Summarized proceedings of a conference on the physics of lubrication—Manchester 1950. R. SCHNURMANN. *Brit. J. Appl. Phys.*, **1**, 275–85 (*Nov.* 1950).

Papers are summarized at about 300 words each. On hydrodynamic lubrication and the rheology of lubricants papers were: "Survey of hydrodynamic lubrication" (D. G. Christopherson), "The rheology of lubricant films" (E. W. J. Mardles), "The viscosity of lubricating oils at high rates of shear" (A. F. H. Ward, S. M. Neale, N. F. Bilton), "The lubrication of textiles" (E. Moss). On boundary layer and extreme pressure lubrication the following papers were read: "Boundary layer and extreme-pressure lubrication" (D. Clayton), "The structure of the boundary layer" (G. I. Finch), "Boundary film lubrication failure" (T. B. Lane), "Lubrication with materials in the solid state" (F. T. Barwell and A. A. Milne), "The lubrication of rough steel surfaces by a series of soaps" (F. T. Barwell and A. A. Milne), "The lubrication of metals by long chain organic compounds" (K. V. Shooter), "A study of boundary lubricant films by electron diffraction" (J. W. Menter), "The adsorption of lubricant films: a study by radioactive tracers" (A. C. Moore), "The spreading behaviour and lubricating properties of mixed liquids" (E. W. J. Mardles, E. Bielak, E. Tingle), "The electrostatic component of the force of friction" (R. Schnurmann), "Surface welding and the extreme pressure lubricant" (G. I. Finch and R. T. Spurr), "Physical changes in rubbing surfaces on scuffing" (C. H. M. Jenkins and D. Clayton), "An investigation of surface damage using radioactive metals" (E. Rabinowicz), "The influence of lubricants on friction, wear and abrasion" (P. Grodzinski). 36 refs.

532.517.

867. The laminar boundary layer on solids of revolution. L. G. WHITEHEAD AND G. S. CANETTI. *Phil. Mag.*, **41**, 988–1000 (*Oct.*, 1950).

The boundary-layer flow past solids of revolution is analysed by a method already developed for the two-dimensional case and shown to be related to the corresponding two-dimensional flows past wedges; a general approximation being found to give satisfactory solutions for the accelerated part of the boundary layer of slender bodies and the earlier part of the retarded flow. The method fails, however, close to the laminar separation point.

L. J. GOODLET

532.52

868. A note on the hodograph transformation for the two-dimensional vortex flow of an incompressible fluid. S. GOLDSTEIN AND M. J. LIGHTHILL. *Quart. J. Mech. Appl. Math.*, **3**, 297–302 (*Sept.*, 1950).

In the hodograph transformation of the two-dimensional vortex flow of an incompressible, inviscid fluid, branch lines arise, similar to those previously encountered in the theory of the irrotational supersonic flow of a gas. The result is of importance for the calculation of vortex flows with "free" streamlines, and in particular for the calculation of jets with vorticity present. As a simple mathematical example the hodograph plane is described corresponding to the flow of a stream with uniform shear past a circular cylinder; the hodograph plane is a Riemann surface of 6 sheets. A.

532.525

869. On the transonic flow of a compressible fluid through an axially symmetrical nozzle. S. TOMOTIKA AND Z. HASIMOTO. *J. Math. Phys.*, **29**, 105–17 (*July*, 1950).

The fundamental differential equation is transformed into a simpler form for velocities differing only slightly from the critical velocity of sound. The result is the same as that obtained by von Kármán in the study of the similarity law of transonic flow past slender bodies. Exact solutions and their applications are given and the flow through a constriction in a nozzle with circular cross-section is examined in detail. Numerical calculations confirm Stanton's prediction that there is a limit to the occurrence of the approximately symmetrical type of flow. An explanation is given of the transition from the limiting form of the symmetrical flow to the asymmetrical unique flow. E. H. DOCK

532.528 : 532.73–1

870. Gas evolution in liquids and cavitation. P. H. SCHWEITZER AND V. G. SZEBEHELY. *J. Appl. Phys.*, **21**, 1218–24 (*Dec.*, 1950).

Nine heavy lubricating oils, four light lubricating oils, three aircraft engine fuels, one Diesel fuel, and distilled water were tested for their air solubility and for the rate of solution and evolution of air when equilibrium is disturbed. A wide variation exists in the solubility constants and rates, but the rate of evolution was always found to be proportional to the supersaturation, and the rate of solution to the undersaturation, under otherwise similar conditions. At room temperature the air solubility constant for distilled water is 1·84%, for a gasoline approximately 20%, and for (light and heavy) lubricating oils approximately 10%. The "half-life" for evolution on the other hand was 3·86 sec for distilled water, 0·13–0·24 sec for gasoline, 3·6–7·6 sec for light, and 11·6–51·4 sec for heavy lubricating oils. The investigation gave some insight into the phenomenon of cavitation.

532.58

871. The virtual mass of a sphere entering water vertically. A. MAY AND J. C. WOODHULL. *J. Appl. Phys.*, **21**, 1285–9 (*Dec.*, 1950).

The manner in which a sphere behaves when it enters the water from air depends on the rate at which energy is taken from it, and most of this energy is utilized in setting water into motion. The virtual mass is a partial measure of this motion. An investigation of virtual mass for spheres shortly after vertical water entry is described. The spheres used had specific gravities between 1·06 and 16·77 and impact velocities ranged from 21 to 103 ft/sec. The value of the virtual-mass coefficient was found to be much smaller than had previously been estimated, an average value of 0·08 being obtained. The method used recognizes the dependence of C_D on sphere speed and depth, and makes comparisons only where these parameters have the same value. A.

532.58

872. Shadowgrams of spherical missiles entering water at supersonic speeds. J. H. MCMILLEN, R. L. KRAMER AND D. E. ALLMAND. Letter in *J. Appl. Phys.*, **21**, 1341–2 (*Dec.*, 1950).

532.594

873. On the steady surface ripples of a cylindrical flow. Y. WADA. *J. Phys. Soc. Japan*, **5**, 259–62 (*July–Aug.*, 1950).

CAPILLARITY 532.6

532.6 : 532.72

874. The effect of pressure and chain length on desorption. L. SHARAGA. *C.R. Acad. Sci., Paris*, **231**, 335–7 (*July* 31, 1950) *In French.*

Further study [see Abstr. 8535 (1950)] of films of lauric and myristic acids confirms that the desorption is governed by diffusion. Diffusion constants are found and Traube's law verified. R. H. DAVIES

532.6 : 541.183.36

Adsorption of insoluble vapours on a water surface. *See Abstr.* 1455

532.65

875. Production of uniform droplets. N. A. DIMMOCK. Letter in *Nature, Lond.*, **166**, 686–7 (*Oct.* 21, 1950).

A method is described whereby streams of droplets of uniform size may be generated by the vibration of a hollow glass reed containing the liquid. The vibrations in the reed are induced by means of a short length of steel hypodermic tubing, attached to the reed and acting as an armature, which itself oscillates under the influence of a small electromagnet supplied with a.c. By adjustment it is possible to obtain diameters ranging from 10 to 300μ. T. C. TOYE

532.69 : 531.43

876. Sliding of drops from surfaces of different roughnesses. J. J. BIKERMAN. *J. Coll. Sci.*, **5**, 349–59 (*Aug.*, 1950).

Water drops slide without acceleration along tilted plates of stainless steel at such an angle α that $W \sin \alpha = kw$, if W is the weight and w the width of the drop, and k is a constant. The value of k increases with surface roughness from 48 g/sec.$^{-2}$ for polished steel (average height of hills 0·02–0·03μ) to 99 g/sec.$^{-2}$ for pickled steel (average height of hills 3·1μ). These results are accounted for by surface

tension effects only, without regard to wetting. Some earlier work on friction between solids and liquids is examined. A.

MOLECULAR THEORY OF LIQUIDS . 532.7

532.739.2

877. An irregularity in the solvent powers of paraffins. J. H. HILDEBRAND. *J. Chem. Phys.*, **18,** 1337–8 (*Oct.*, 1950).

The solubility relations of *n*-heptane with *f*-heptane, I, S, SnI_4 and P are all accounted for within the usual limits of accuracy for regular solution theory by a solubility parameter 8·1 instead of the value 7·45 derived from its energy of vaporization per cm^3. Solutions of 2,2,4-trimethyl pentane with *f*-heptane and with I are similarly accounted for by the empirical value 7·45 instead of 6·85. Such an adjustment for paraffins is a practical alternative to the treatment used by Simons and Dunlap for the system *n*-pentane, "pentforane," which they recently reported upon, and is, at the same time, consistent with their assumption that the exceptional behaviour of paraffins is to be attributed to an irregularity in their mutual repulsions. A.

532.77

878. A test of ideal solution laws for H_2, HD and D_2. Vapour pressures and critical constants of the individual components. R. D. ARNOLD AND H. J. HOGE. Letter in *J. Chem. Phys.*, **18,** 1295 (*Sept.*, 1950).

MECHANICS OF GASES 533

533.15 : 536.71

879. Transport properties of dense media. I. Thermal diffusion in isotopic mixtures of gases. W. L. ROBB AND H. G. DRICKAMER. *J. Chem. Phys.*, **18,** 1380–2 (*Oct.*, 1950).

Based on Meixner's thermodynamics for irreversible processes, and the work of Haase, an equation for the thermal diffusion ratio α, which can be evaluated from the equation of state, is presented. Using van der Waals' equation, α's are calculated in the critical region and compared with data for ethane-xenon. The equation reproduces all the essential features of the experimental results. Calculations made for a mixture of isotopes indicate that the effect of pressure on α cannot be attributed to selective clustering. A.

533.5

880. Leak detectors for industrial vacuum systems. A. GUTHRIE. *Electronics*, **23,** 96–101 (*Sept.*, 1950).

The main desiderata for such detectors are: (1) capability of measuring total leakage and isolating individual leaks; (2) rapidity in response; (3) high sensitivity; (4) adaptability to any vacuum system without loss of vacuum; (5) relative simplicity and low cost; and (6) selectivity. Of eight tabulated methods, the He leak detector is generally the most useful for rapid operation. It is based on the vacuum analyser, a form of small-radius mass spectrometer. It consists of a non-magnetic tank, supported by and connected to the vacuum line, and in it are mounted a cold-cathode positive-ion source, a collector, and a magnet system. A sweep voltage superposed on the ion-accelerating voltage sweeps the He mass peak across the collector slot. The collector is connected through an amplifier chain to (1) a c.r.o. with horizontal sweep in phase with the other sweep voltage, (2) a leakage-detecting meter following a filter for removing all frequencies except the sweep frequency, and (3) a 1 kc/s "squealer" circuit. Leak sensitivity $\simeq$ 1 part of He in 2×10^5 parts of air and is limited by noise in the amplifier, stray frequency pick-up, and ion background. Methods of determining sensitivity are described and response time discussed. The whole procedure of searching for leaks and their subsequent repair is explained in detail. H. G. M. SPRATT

533.5

881. Conference on vacuum physics—Birmingham 1950. L. RIDDIFORD. *Brit. J. Appl. Phys.*, **1,** 273–4 (*Nov.*, 1950).

The Conference served the two purposes of a review for industrialists, of the present position in vacuum technique and an opportunity for presentation of original work. The papers and the discussions are summarized.

533.5

882. Measurement of the pumping speed of sliding vane pumps. R. HENRY. *Vide*, **5,** 859–65 (*July–Sept.*, 1950) *In French.*

After stating definitions of pumping speed and efficiencies, the author describes the method and apparatus used for measuring pumping speed, and comments on the various types of flow of gases through pipes. The fact that, at low pressures, pumping speed increases with decrease of rotor speed is verified experimentally, and this is explained. Some parameters influencing pumping speed, and the factors determining the low-pressure limit, are discussed. Experimental results obtained with six French and American pumps are tabulated. A formula for calculating displacement from the geometry of the pump is given. G. WITTENBERG

533.5

883. On the vapour flow in the diffusion pump. S. OYAMA. *J. Phys. Soc., Japan*, **5,** 192–7 (*May–June*, 1950).

The effects of vapour pressure, Mach number and jet design on back-flow in a Hg vapour pump are investigated mathematically. The advantage of supersonic flow is emphasized. L. G. CARPENTER

533.6.011

884. On the asymptomic expansion in three-dimensional compressible viscous flow. M. Z. KRZYWOBLOCKI. *J. Franklin Inst.*, **250,** 213–18 (*Sept.*, 1950).

533.6.011

885. Erratum: Transonic potential flow of a compressible fluid. W. R. SEARS. Letter in *J. Appl. Phys.*, **21,** 1341 (*Dec.*, 1950).

See Abstr. 7064 (1950).

533.6.011

886. Plane rotational Prandtl–Meyer flows. M. H. MARTIN. *J. Math. Phys.*, **29**, 76–89 (*July*, 1950).

A Prandtl–Meyer flow is defined as a flow in the physical plane whose hodograph degenerates into a single curve h in the hodograph plane. This leads to the possibility of direct generalization from the classical irrotational flow to the rotational case. Full analytical proof is given and the defining theorems set up. L. J. GOODLET

533.6.011 : 534.222.2

887. Prandtl–Meyer flow behind a curved shock wave. R. C. RAND. *J. Math. Phys.*, **29**, 124–32 (*July*, 1950).

An indirect method is presented of measuring the error due to the assumption of a Prandtl–Meyer regime behind a shock wave, by constructing a free stream compatible with a Prandtl–Meyer flow and a curved shock wave, and comparing this with a uniform stream. L. J. GOODLET

533.6.011 : 536.7

888. The effect of irreversibilities in a cylindrical burner tube. M. ROY. *C.R. Acad. Sci., Paris*, **231**, 533–5 (*Sept.* 11, 1950) *In French.*

An extension of a previously developed simplified, unidimensional theory of burner tubes showing the effect of viscosity in particular at the boundaries of the flow. The influence of the irreversible factors is analysed, and the result obtained that in conventional burner tubes of jet engines values of the chemical constant α approaching unity are unattainable.

L. J. GOODLET

533.6.011.31

889. On some general theorems in the linearized theory of compressible flow. F. URSELL AND G. N. WARD. *Quart. J. Mech. Appl. Math.*, **3**, 326–48 (*Sept.*, 1950).

The linearized equations of motion for steady irrotational isentropic flow past a thin body with a sharp trailing edge are used to evaluate the leading terms in the components of the force acting on the body when there is a vortex wake. It is shown that with certain additional assumptions required by the appearance of infinities at the edges of the wake the linearized theory is adequate for the calculation of the lift and drag on a thin body, but not for the calculation of the lateral force, except in special cases, e.g. when the wing is nearly plane. A quadratic identity involving the drag is used to show that there is at most one solution with given boundary conditions. The corresponding bilinear identity is used to obtain relations between the flow past a thin body and the reversed flow past the same body, when the roles of leading and trailing edges are reversed. These relations hold for both subsonic and supersonic flow and include all flow-reversal theorems obtained by earlier writers. A.

533.6.011.31

890. A simple interferometric test for conical flow. J. H. GIESE, F. D. BENNETT AND V. E. BERGDOLT. *J. Appl. Phys.*, **21**, 1226–31 (*Dec.*, 1950).

In conical flows the velocity, pressure and density do not vary on lines through the vertex of the cone. It is shown that for interferograms of general conical flows $\delta(y, z)/z = f(y/z)$, where y and z are any set of Cartesian co-ordinates with origin at the image of the vertex of the cone, and δ is the fringe shift at y, z. Thus, for strictly conical flow, a graph of $\delta(y, z)/z$ *versus* y/z should be a single curve. This suggests a test for approximate conicity that requires very little computation. This test is applied to interferograms obtained from a number of approximately axisymmetric flows at various Mach numbers about cone-cylinders in free flight. Plotted fringe shift data from the region near the nose fall into a narrow band, an indication of approximate conicity. They also closely check the corresponding theoretical fringe shift curve calculated for Taylor–Maccoll flow. A.

533.6.011.311

891. On velocity fluctuations in the laminar boundary layer. I. Y. SHIGEMITSU. *J. Phys. Soc. Japan*, **5**, 298–304 (*Sept.–Oct.*, 1950).

533.6.011.5

892. Reflection at a laminar boundary layer of a weak steady disturbance to a supersonic stream, neglecting viscosity and heat conduction. M. J. LIGHTHILL. *Quart. J. Mech. Appl. Math.*, **3**, 303–25 (*Sept.*, 1950).

A perfect gas, with constant specific heats and zero viscosity and thermal conductivity, is considered to flow in a steady two-dimensional pattern which is only slightly disturbed from a basic flow parallel to a solid plane wall. The Mach number of the basic flow varies continuously and monotonically from zero at the wall to a supersonic value at a distance δ from the wall, beyond which it takes this supersonic value uniformly. The disturbance is considered to be due to a weak stationary simple plane wave incident on the "boundary layer" from outside. The streamline pattern and pressure coefficient distribution, resulting from a given incident wave, are found to depend only on the Mach number distribution in the basic flow (not on the individual velocity and temperature distributions). Any singularity in the incident wave is propagated along characteristics in the supersonic part of the layer (increasing in strength) and is reflected from the sonic line modified in character. A.

533.6.08 : 531.787

893. A simple manometer for use in measuring low air velocities. D. B. SPALDING. *J. Sci. Instrum.*, **27**, 310–12 (*Nov.*, 1950).

Two designs of a simple direct-reading instrument are described for measuring steady differential air pressure down to 0·002 mm of water column. The differences of liquid level are magnified by the tilting of a mirror supported on floats. A.

533.6.08 : 533.6.011.6

894. On experimental methods of the investigation of turbulent flow. II. Y. SHIGEMITSU. *J. Phys. Soc. Japan*, **5**, 207–13 (*July–Aug.*, 1950).

Application of theoretical results obtained in previous part [Abstr. 139 (1951)] to turbulent velocity fluctuations measurement. A.

533.6.08 : 621.317.727 : 621.317.39

895. A compensating circuit for the Simmons shielded hot-wire anemometer. L. L. FOX, P. L. PALMER AND D. WHITTAKER. *J. Sci. Instrum.*, **27**, 289–91 (*Nov.*, 1950).

Small changes in the current through the heater wire of a Simmons shielded hot-wire anemometer

cause large errors in the measured air flow. This arrangement injects a small e.m.f. from the heater wire circuit into the thermocouple circuit, so that the net e.m.f. which is measured is largely independent of small changes in heater current. A small "backing-off" e.m.f., derived from a large-capacity dry cell under light load, is then used to restore the output to a level convenient for application to a recording potentiometer. A.

MOLECULAR THEORY OF GASES . 533.7

533.7

896. The thermal de-mixing of gases at high pressures. E. W. Becker. *Z. Naturforsch.*, **5a**, 457–65 (*Aug.*, 1950) *In German.*

Determination of the pressure-dependence of the thermal diffusion coefficient α for CO_2/H_2, CO_2/N_2, CO_2/A, CO_2/CH_4, N_2/H_2, N_2/CH_4 by the double bulb method between 3 and 80 atm. at a mean temp. of 84°c. There is a marked increase of α with pressure for the first 4 combinations, a small increase for N_2/H_2 and a decrease for N_2/CH_4. For CO_2/H_2 results at varying mean temperatures and concentrations are also given. For N_2/H_2 a change of sign of α at 1·8 atm. at 50°c was shown in an experiment with a Clusius Dickels tube. The results can be interpreted as the superposition of two effects: the Chapman–Enskog thermal diffusion of an ideal gas and the difference in the change of density with temperature at constant partial pressure of two real gases which are considered as independent. The latter effect causes an increase of α, if the latter is defined by grad $\gamma = \alpha\gamma(1-\gamma)$ grad $\ln T$, where γ is the mole fraction of the component which has the smaller deviation from the ideal gas law. This latter effect becomes predominant at high pressures. Though both effects cause a change of γ, only the Chapman–Enskog effect causes a change in the partial pressure with temperature. This partial pressure change is demonstrated in an experiment with H_2/A where the partial pressure of H_2 is measured directly, using Pa tubes as semi-permeable walls. The influence of the real gas effect on the diffusion thermoeffect is discussed. H. London

533.7

897. Vibrational relaxation times in gases. W. Griffith. *J. Appl. Phys.*, **21**, 1319–25 (*Dec.*, 1950).

Relaxation times for 17 gases have been measured using a steady-flow method, the velocity field being found numerically by Southwell's relaxation method. Where a comparison is possible the results are found to be in good agreement with sound dispersion data. The present state of knowledge about relaxation effects is discussed and a few instances of their possible appearance are cited. A.

533.7 : 541.183

898. The accommodation coefficients of gases on platinum as a function of pressure. L. B. Thomas and R. E. Brown. *J. Chem. Phys.*, **18**, 1367–72 (*Oct.*, 1950).

The accommodation coefficients of 9 gases on Pt at various temperatures in 6 different tubes are presented as a function of pressure. In all cases the accommodation coefficients show a constant value as the pressure is lowered toward zero, which is in contradiction to results reported by Amdur and coworkers. Reasons for disagreement are suggested and criticism of an earlier paper is answered. Presumably specially reliable values of the accommodation coefficients of A and Kr taken in one of the tubes are given and this tube and method of operation are described in detail. A.

533.75

899. The third virial coefficient for non-polar gases. R. B. Bird, E. L. Spotz and J. O. Hirschfelder. *J. Chem. Phys.*, **18**, 1395–1402 (*Oct.*, 1950).

This has been calculated with great accuracy by means of punched-card techniques. The Lennard-Jones potential, with inverse 12th-power repulsion and inverse 6th-power attraction, was used in the calculations. Excellent agreement with the computations of Kihara was obtained at very high temperatures; in the moderate temperature region agreement with those of Montroll and Mayer and those of de Boer and Michels is moderately good. A comparison with experimental data indicates fairly good agreement for the approximately spherical molecules A, CH_4 and N. In other cases there are discrepancies suggesting deviations from the form of the interaction energy assumed. There is considerable difficulty in obtaining accurate third virial coefficients from the equation of state data. A method of estimation for mixtures of gases is suggested. The functions which are tabulated should be particularly useful for extrapolating the equation of state to very high temperatures, where no experimental data are available. The zero-pressure derivative of the Joule–Thomson coefficient with respect to pressure provides additional means for comparing the tabulated functions with experimental data, and the deviations are consistent with those discovered by comparison of the third virial coefficients themselves. A.

VIBRATIONS . ACOUSTICS 534

534.11

900. Steady forced vibration of a non-conservative system with variable mass; a pumping system. R. S. Ayre, L. S. Jacobsen and A. Phillips. *J. Franklin Inst.*, **250**, 315–38 (*Oct.*, 1950).

A theoretical and experimental treatment of the steady forced vibration of a single-degree-of-freedom system, with stepwise variation in mass, and by which external work is done. The deep-well reciprocating pump has been used as an example of such a system although in doing so it is necessary to consider the pump a highly idealized, undamped system with lumped parameters. The main purpose has been to study the effect of variation in mass. The theory considers two linear systems, one of mass M, the other of mass $M + m$, the boundary conditions of which must be made to agree. Four distinct "Classes of Motion" are shown; three of them involve an

over-travel of the secondary mass, *m*. The experimental apparatus is mechanical. A.

534.212

901. The equivalent circuit for the transmission of plane elastic waves through a plate at oblique incidence. W. T. THOMSON. *J. Appl. Phys.*, **21**, 1215–17 (*Dec.*, 1950).

Equations are developed for the transmission of a plane elastic wave through a plate at oblique incidence with unequal fluid medium on each side of the plate. The plate transmitting both the dilatation and shear wave is reduced to a simple equivalent circuit with impedances which are functions of the incidence angle. A.

534.22 : 536.633.3

902. The velocity of sound in helium at temperatures — 78°C to 200°C and pressures up to 70 atmospheres. W. G. SCHNEIDER AND G. J. THIESSEN. *Canad. J. Res. A*, **28**, 509–19 (*Sept.*, 1950).

The velocity of sound in pure He gas has been measured as a function of pressure at — 78°, 0°, 50°, 100° and 200°C, using an ultrasonic interferometer of the double crystal type. From the sound velocity data second virial coefficients were obtained, and the ratio of specific heats was derived as a function of pressure. A.

534.22.094.1

903. Velocity of sound in metals. S. BHAGAVANTAM AND K. RAMAVATARAM. *Proc. Indian Acad. Sci. A*, **32**, 197–9 (*Sept.*, 1950).

It has been experimentally shown, by applying the ultrasonic wedge method, that the sound velocity in brass and Al plates is independent of frequency in the range 1 to 10 Mc/s. For obtaining this result unambiguously, one has to use plates of proper thicknesses and lateral dimensions and eliminate coupling and boundary effects. A.

534.232 : 534.321.9

904. On the initiation of audible combination tones from primary oscillations in the ultrasonic range. H. H. MÜLWERT. *Naturwissenschaften*, **37** (*No.* 17) 398–9 (1950) *In German.*

The "strip" radiator of H. H. Mülwert has been used to produce ultrasound of continuously variable frequency in the range 20 to 280 kc/s, practically free from overtones and subharmonics. Reference is made to research in progress using two such ultrasonic radiators to produce audible combination tones. The frequencies of such tones are given by $\pm \alpha p \pm \beta q$, where α and β are whole numbers and p and q are the primary ultrasonic frequencies. A. B. WOOD

534.321.9

905. Ultrasonic interferometry in gases. I. S. PETRALIA. *Nuovo Cim.*, **7**, 705–14 (*Sept.* 25, 1950) *In Italian.*

After a reference to the principal questions connected with the scattering of ultrasonic waves in gases, a variable path interferometer is described which allows the determination of the propagation constants (velocity and absorption coefficient) of ultrasonic waves in gases and vapours, for frequencies between 50 and 2 000 kc/s and the experimental technique is discussed. Notice is given of some preliminary measurements made in CO_2 (known to be dispersive) and in lighting gas, from which results that there is velocity dispersion also in this latter gas, in the frequencies between 58 and 1 400 kc/s. A.

534.321.9

906. Satellite resonances in ultrasonic interferometry. J. F. W. BELL. *Proc. Phys. Soc., Lond., B.*, **63**, 958–64 (*Nov.*, 1950).

An experimental investigation into the origin of satellite resonances has been carried out by the author. They are identified as mode resonances of the gas in the interferometer tube and are of the type described by Lord Rayleigh. The presence of unresolved satellites in the principal interferometer resonance introduces a considerable error into absorption measurements. Results obtained by Van Itterbeek and his co-workers are shown to be in agreement with the Krasnushkin interferometer theory, which takes into account the effect of the multiple nature of the principal resonance. A criterion for the choice of crystals for ultrasonic absorption measurements is given. A.

534.321.9

907. Ultrasonic absorption in the critical temperature region. W. G. SCHNEIDER. Letter in *J. Chem. Phys.*, **18**, 1300 (*Sept.*, 1950).

534.321.9

908. Ultrasonic velocity of sound at 12 Mc in liquid sulfur. O. J. KLEPPA. Letter in *J. Chem. Phys.*, **18**, 1303 (*Sept.*, 1950).

534.321.9

909. Ultrasonic velocities of sound in some metallic liquids. Adiabatic and isothermal compressibilities of liquid metals at their melting points. O. J. KLEPPA. *J. Chem. Phys.*, **18**, 1331–6 (*Oct.*, 1950).

The ultrasonic velocities of sound at 12 Mc/s in 12 pure liquid metals at their melting points under atmospheric pressure and in 4 equi-atomic liquid metallic mixtures have been determined by the use of the electronic pulse-circuit technique. For the pure metals the adiabatic and isothermal compressibilities have been computed. The compressibilities were generally found to be somewhat larger than for the corresponding solids at room temperatures. A calculation of Grüneisen's γ for the liquid metals shows that this quantity, in the case of normal metals, does not change appreciably on going from the solid state at room temperature to the liquid at moderately elevated temperature. These facts support the familiar view that the liquid metals at temperatures not far above their melting points are in a "solid-like" state, and that equations of state for the solid state may be applicable to such liquids. A.

534.321.9

910. Ultrasonic classification of organic liquids. G. S. VERMA. *J. Chem. Phys.*, **18**, 1352–4 (*Oct.*, 1950).

Ultrasonic absorption in various organic liquids at 4 different frequencies 1·00, 1·46, 2·89 and 4·00 Mc/s as well as their temperature coefficient of absorption (25°C to 60°C) have been studied by ultrasonic interferometer. Liquids have been classified into 4 broad groups: Class I, in which absorption due to changes in the heat content of the medium predominates; Class II, in which absorption caused by structural changes in the quasi-crystalline structure of the liquid

state predominates; Class III, in which viscosity of the medium alone accounts for absorption; and Class IV, where absorption is not proportional to the square of the frequency. A.

534.321.9 : 538.65 : 539.32

911. Some magneto-acoustic effects in nickel. T. F. Rogers and S. J. Johnson. Letter in *J. Appl. Phys.*, **21**, 1067–8 (*Oct.*, 1950).

Initial results on the influence of a magnetic field on the propagation of the transverse (shear) wave in a Ni rod are described. A decrease was observed in the propagation time delay ("electric length") with increase in magnetic field strength which was about 1 000 times greater than that expected from the magnetostrictive effect. It is suggested that there is an increase in the acoustic velocity of propagation within a Ni rod when it is subjected to a magnetic field, due to a change in the value of the rigidity modulus. There was also a large decrease in attenuation on applying the field, but no explanation of this is offered. H. J. H. STARKS

534.321.9 : 538.652

912. On the magnetostriction vibrator as a source of supersonics. Y. Takesada. *J. Phys. Soc. Japan*, **5**, 197–9 (*May–June*, 1950).

The acoustic power transmitted at 23·6 kc/s by a magnetostrictive vibrator employing the 13% Al–Fe alloy "Alfer" was measured at depths of up to 5 m in the sea for various input powers. The absorption coefficient of the sound near the vibrator due to cavitation is shown theoretically to be $\alpha = |\omega(V/C - 1)/V|$ where V and C are the velocities of sound in water and in the air-fluid mixture respectively. G. L. WILSON

534.442.2 : 621.317.35

913. Vibration analysis by search-tone methods. W. Meyer-Eppler. *Arch. elekt. Übertragung*, **4**, 331–8 (*Aug.*, 1950) *In German.*

Reference is made to the importance of the determination of the spectrum of electrical and mechanical vibrations. The various known systems of analysis by the search-tone principle are classified and tabulated. Typical methods are: dynamometer wattmeter, electrometer, ring modulator, additive mixing, thermal, rotating commutator (rectifier). A table indicating various types of filters (electric and electromechanical) is given. A. B. WOOD

534.614 : 534.321.9

914. A new method for measuring velocities of ultrasonic waves in liquids. B. Ramachandra Rao. Letter in *Nature, Lond.*, **166**, 742 (*Oct.* 28, 1950).

534.78

915. Some effects of side-tone delay. B. S. Lee. Letter in *J. Acoust. Soc. Amer.*, **22**, 639–40 (*Sept.*, 1950).

Using a magnetic tape recorder with separate recording and playback head, the author describes an experiment in which a person's voice may be returned to his own ears (using a telephone headpiece connected to the playback circuit), but delayed up to the length of time the tape requires to move from one magnet to the next. The effect of this delayed and dominating "echo" is startling—causing the person to stutter, slow down while raising his voice in pitch and volume, or to stop completely. The same effect, to a feebler degree, has been noticed with public address systems where the loudspeaker is at a sufficient distance from the microphone to delay the return by about $\frac{1}{8}$ second. The attention of those who study psycho-acoustics, speech therapy and theoretical physiology, is drawn to this interference with our normal speech-monitoring system. A. B. WOOD

534.843

916. General theory of intelligibility in rooms. T. Korn. *Ann. Telecommun.*, **5**, 316–20 (*Aug.–Sept.* 1950) *In French.*

Contrary to the "classical" view, the author contends that the time of reverberation is not the only important factor determining the intelligibility of speech in rooms. A factor of primary importance is the action of the direct sound. After discussing the researches of Knudsen and Bolt, a method is described for the calculation of the "articulation index" of a room. Curves are shown which indicate that the direct sound plays as important a part in intelligibility as the time of reverberation of the room. The calculated results are verified experimentally. The intelligibility factor, depending on the ratio of direct sound to reverberation, can be improved by architectural methods or by electronic amplification and the use of highly directive loudspeakers. A. B. WOOD

534.861.1 : 621.396.712.1

917. Measurement of the reverberation times of the studios of La Radiodiffusion Française. J. Pujolle and J. Boisard. *Ann. Télécommun.*, **5**, 307–15 (*Aug.–Sept.*, 1950) *In French.*

A description is given of the apparatus used in the measurement of reverberation times, viz.: (1) sound sources of various kinds (a generator which employs the noise of the whistle produced by a neon lamp was generally used—a Siemens analyser indicating a fairly flat frequency distribution between 56 c/s to 7·2 kc/s); (2) microphone (Western type 630 A pressure microphone); (3) filters (a series of active band-pass types, with suitable overlaps—covering a range 50 c/s to 15 kc/s); (4) amplifier (having a linear response to $\pm$ 1 db from 30 c/s to 15 kc/s; and (5) logarithmic recorder (Neumann type permitting measuring time of reverberation of the order 0·1 to 0·15 sec). Specimen records are shown and various characteristics are discussed, including the accuracy obtainable in the various frequency ranges. The equipment has been extensively used for reverberation measurements in studios in Paris and the provinces. Acoustic absorption coefficients of various materials have also been determined by the same method. A. B. WOOD

OPTICS . RADIATION . SPECTRA 535

535.1

918. Parageometrical optics. G. Töraldo di Francia. *J. Opt. Soc. Amer.*, **40**, 600–2 (*Sept.*, 1950).

A third branch of optics is shown to exist between

geometrical and wave optics. This intermediate link is called parageometrical optics. Several principles of geometrical optics can be suitably extended to it. A.

535.12 : 534.321.9

919. On the formation of images according to wave theory. R. MERCIER AND L. PETERMANN. *Helv. Phys. Acta*, **23** (*No.* 5) 488–90 (1950) *In French.*

Ultrasonic waves in liquids obey the same laws of propagation as light waves. The distribution of phase and amplitude at the focus of an ultrasonic beam, made visible by Schlieren technique, is a large-scale model of the optical case. A photograph illustrates the phenomena occurring near the focus of a spherical wave. R. W. FISH

535.214.6 : 537.29

920. Combined effect of a high frequency [electric] field and an intense beam of light on particles suspended in air. J. BOUCHARD AND P. TAUZIN. *C.R. Acad. Sci., Paris*, **231**, 841–3 (*Oct.* 23, 1950) *In French.*

Particles of vaseline oil and of solutions of dyes in this oil were suspended in air, and subjected to the h.f. electric field obtained by the oscillatory discharge of a condenser, as well as being illuminated by an intense light. The velocity of longitudinal photophoresis was changed, and it is suggested that the effect is due to preferential orientation of the particles in the field. A magnetic field has no effect. The same result is obtained with powdered Se, Fe, Ni, Co, W, and the smokes obtained by chemical reactions.

N. CORCORAN

535.214.6 : 539.23

921. Properties of thin films and radiometric interpretation of longitudinal photophoresis. J. THIBAUD, M. MAITROT AND J. BERTHIER. *C.R. Acad. Sci., Paris*, **231**, 691–3 (*Oct.* 9, 1950) *In French.*

A theoretical treatment of the effect of heterogeneous radiation on an absorbing sphere. It is shown that a lack of symmetry in temperature rise may occur, due to the absorption. Films of Al, Au, Ag and Pt were illuminated by white light, and the amount of the displacement was found to vary in magnitude and sign with the thickness. Authors suggest that photophoresis may be due to the absorbing properties of thin layers. N. CORCORAN

535.23.08

922. Bolometer of low inertia. M. CZERNY, W. KOFINK AND W. LIPPERT. *Ann. Phys., Lpz.*, **8** (*No.* 1–2) 65–86 (1950) *In German.*

The absorptivity of very thin metal layers for long-wave infrared radiation is independent of the wavelength. Normally, the absorptivity max. is 50% when the square resistance is 188·5 Ω. This is the resistance R^* of the layer of thickness d and specific conductivity σ when the potential is applied across two opposite sides of the square layer. $R^* = 1/d\sigma$. A metallic reflector at a distance of 2·5 mm from the thin absorptive layer increases the absorption by 37% to a total of 68·6%. In this case the square resistance of the layer must be 266 Ω. The thickness of an Ag layer of $R^* = 188{\cdot}5\ \Omega$ is 0·85 Å, and of a Bi layer is 62 Å. The metal layers are deposited on celluloid (zapon lacquer) membranes of 400 Å thickness. The bolometer is of the twin type using Bi layers. The infrared filter is either NaCl or a Tl–Br–I mischcrystal. The membranes must not be exposed to temperatures in excess of 130°C. The manufacture of both the membrane and the metal layer are discussed in detail. The threshold sensitivity of the bolometer described is 0·4 ergsec^{-1}. W. SUMMER

535.233

923. On the optical emissivity of thoria. G. MESNARD AND R. UZAN. *Vide*, **5**, 844–52 (*July–Sept.*, 1950) *In French.*

A layer of thoria was deposited by cataphoresis on, in most cases, a W wire of about 0·1 mm diameter, and the wire enclosed in a glass envelope which was then evacuated. The thoria and W support temperatures were compared with a monochromatic (0·65 μ) optical pyrometer. The variation of emissivity with temperature, time, the nature of the support (Mo and W), the thickness of deposit, and the effect of preliminary flashing in H, were measured and the results are shown graphically. Several explanations of the results are suggested, but these are admittedly incomplete and require confirmation.

S. WEINTROUB

535.233.5.08 : 778.6 : 771.44

924. Direct-reading colour (-temperature) meter for the measurement of light sources, especially in colour film technique. *Foto-Kino-Tech.*, **3**, 107–8 (*May*, 1949) *In German.*

An explanation of colour temperature is given by showing how the frequency distribution of light depends upon the temperature of the source (the Wien displacement law, 1893). A given frequency distribution may be characterized by the ratio of the intensities of red and blue. It is therefore possible to construct a meter from two photo-cells, one sensitive to red (and infrared) light and the other sensitive to blue, incorporated in a bridge circuit. The galvanometer is calibrated against a source of the correct colour temperature, and the values of the circuit components are chosen so that balance is obtained in the centre of the scale. The limits of tolerance are marked, beyond which the light is too red, or too blue. PHOTOGRAPHIC ABSTRACTS

535.247

925. Measurement of photographic transmission density. K. S. WEAVER. *J. Opt. Soc. Amer.*, **40**, 524–36 (*Aug.*, 1950).

This investigation was carried out primarily to determine the relation between the sphere and pot-opal types of densitometers, and the factors which affect their reproducibility from specifications. The two sources of error which have been given the greatest consideration are the directional variation in the luminance of the sphere or opal glass used to illuminate the test sample, and the "build-up" of the luminance of the illuminator by light reflected back from the test sample. The net difference between the pot-opal and sphere densitometers was found to be about 0·04 at low densities, decreasing to about 0·01 to 0·02 at high densities. It is concluded that the inherent differences between the sphere and pot-opal densitometers is small and that either can be readily reproduced from specifications. A.

535.247 : 522.613

926. A sensitometer for the calibration of photographic images of extended objects during exposure. W. FRICKE. *Z. Astrophys.*, **27** (*No.* 2) 156–60 (1950) *In German.*

Description of a Pt wedge sensitometer for use on the Schmidt reflector of the Hamburg–Bergedorf Observatory (36/44 cm, $f = 62{\cdot}5$ cm), and designed to exceed the accuracy hitherto achieved in surface photometry. During the observation a neutral wedge is copied on the photographic plate with the same exposure time as the object, and without introducing any additional instrumental devices into the lightpath of the telescope. The author uses his instrument also, in accordance with W. Becker's proposals, in conjunction with extrafocal images of some standard stars, which are obtained simultaneously with the focal photograph of the object (e.g. as at present, the Andromeda nebula). This is done by fixing a smaller plate (3×4 cm) on part of the focal plate (9×12 cm); both plates are parts of the same larger plate. A. BEER

535.247.4 : 537.533.72 : 621.385.833 : 621.383

927. Photometer for electron microscope. F. W. BISHOP. *Electronics*, **23**, 110–11 (*Sept.*, 1950).

The instrument is used to determine the exposure time for photographing the fluorescent screen. To meet the required sensitivity, a 931 A multiplier phototube is employed and a balanced valve voltmeter, incorporating two 6J7 valves and a 0–200 microammeter, connected across its anode load to provide a measure of the light received from the screen. Setting of the zero and of an arbitrarily selected full-scale deflection point complete the calibration. The phototube is mounted externally on the microscope column and is protected by a brass tube in which a slot is milled and so orientated that it picks up light from that part of the screen on which the useful image falls. The preferred procedure is to adjust the light intensity by means of a condenser lens to give a predetermined meter reading and to use a constant exposure time. H. G. M. SPRATT

535.314

928. The angle of incidence as a function of the angle of deviation and the refractive indices. P.-E. WEBER. *Optik*, **7** (*No.* 3) 169–71 (1950) *In German.*

The usual law of refraction at a surface separating two media of known refractive index is transposed so that the necessary angle of incidence of a light ray can be found directly from the required deviation.

R. W. FISH

535.316

929. A method of detection and measurement of elliptical astigmatism. R. CASTAING. *C.R. Acad. Sci., Paris*, **231**, 835–7 (*Oct.* 23, 1950) *In French.*

The elliptical astigmatism of an optical system may be measured by employing the system as a reducing lens in a shadow microscope; and examples are given of the types of distortion produced in the image of a fine wire. Experiments have been carried out with an ordinary luminous source and a cylindrical lens. The application of the method to an electron lens is to follow. J. THEWLIS

535.31

930. On Lange's representation of the 3rd-orde image errors. II. H. MARX. *Optik*, **7** (*No.* 2) 91- (1950) *In German.*

It is now recognized that the representation de cribed in part I [Abstr. 3219 (1948)] is essentially tha given by Lange. In part I, variation of the para meters could lead to impracticable separation between successive surfaces. A method is now give which avoids this difficulty. In addition a procedur is described for avoiding indeterminacies in the case of plane surfaces. H. H. HOPKIN

535.317.

931. The calculation of aberrational and Eikona coefficients of any order for symmetrical optica systems with spherical and plane surfaces. H. MARX *Optik*, **4** (*No.* 2/3) 97–148 (1948) *In German.*

Recurrence formulae are developed for the aberra tional coefficients of any order for both meridional an skew rays. These give the coefficients of any order in terms of the coefficients of order $(p–2)$ and so allow the higher aberrations to be built up from the Gaussia coefficients. Computing procedures and schedule are given suitable for use with calculating machines The Eikonal coefficients of the system can also b calculated by a similar procedure. R. W. FISH

535.318 : 621.317.75

932. An aspherical objective of high light grasp fo cathode-ray oscillography. D. MAEDER. *Helv. Phys Acta*, **23** (*No.* 5) 476–8 (1950) *In German.*

Design principles for a lens used in c.r.t. photo graphy at unit magnification are given. Colou correction is not required, while the use of a sym metrical system automatically removes coma and distortion. Aspherical surfaces allow central correc tion at large apertures and correct choice of thickness brings the mean field curvature to zero. R. W. FISH

535.327

933. Temperature variation of the refractive index of lithium fluoride. T. RADHAKRISHNAN. *Proc. Indian Acad. Sci., A*, **31**, 224–8 (*April*, 1950).

This has been measured from 0°c to 400°c for λ4358, 5461 and 5893, and the dependence on temperature of the electronic characteristic frequency of the crystal has been computed therefrom. A.

535.327

934. The refraction of magnesium oxide and its temperature variation. T. RADHAKRISHNAN. *Proc. Indian Acad. Sci. A*, **31**, 229–33 (*April*, 1950).

The temperature coefficient has been determined from room temperature to 400°c at 3 wavelengths, λ4358, λ5461 and λ5893. The coefficients are found to be positive, as is to be expected from photoelastic data. The values are discussed in the light of a dispersion formula for MgO newly proposed by the author, and are used to calculate the temperature shift of the effective characteristic frequency of the crystal in the ultra-violet. A.

535.33.072 : 535.375.5

935. Imaging of bulk radiation in spectrographs. G. HANSEN. *Optik*, **6** (*No.* 6) 337–47 (1950) *In German.*

A radiating volume, such as a tube of liquid in

which Raman radiation is being produced, has to be imaged in the collimator of a spectrograph, and this paper shows how this may be most efficiently done. The author's conception of "light-conductance" ("Lichtleitwert") is used to obtain the same results as Nielsen but more simply [Abstr. 2534 (1947)]. He further treats the problem when internal reflection of Raman radiation within the tube is taken into account, and shows that this internal reflection greatly contributes to the efficiency of observation of Raman radiation. A brief account is given of the analogy between electric current, voltage, and conductance on the one hand, and optical flux, intrinsic luminosity and "light-conductance" on the other. This analogy is used in solving the present problem, and the results may also be used in considering the efficient use of absorption-cells with spectrographs. A. C. MENZIES

535.33.072 : 537.312.5

936. The use of photomultipliers in spectroscopy. D. GLANSHOLM AND B. KLEMAN. *Ark. Fys.*, **2**, *Paper* 29, 305–20 (1950).

The use of a multiplier photocell in addition to the spectrophotographic method is described. In the RCA-type photomultipliers the collector-current/illumination ratio is linear and the fatigue is negligible, for currents $< 1\,\mu$A. A 21 ft grating spectrograph with a scanning range of 100 Å and a 1 m spectrograph with a range of 500 Å have been used. The photoelectric method is superior to the photographic method. W. SUMMER

535.33.072–14

937. Stark effect absorption cells for microwave spectroscopy. D. H. BAIRD, R. M. FRISTROM AND M. H. SIRVETZ. Note in *Rev. Sci. Instrum.*, **21**, 881 (*Oct.*, 1950).

535.33.072–15

938. A rapid scanning spectrometer for oscillographic presentation in the near infra-red. B. W. BULLOCK AND S. SILVERMAN. *J. Opt. Soc. Amer.*, **40**, 608–15 (*Sept.*, 1950).

An instrument for use in the "photo-conductive" i.r. region. It is designed to present spectra from $0{\cdot}36\,\mu$ to better than $5\,\mu$ using a PbTe cell. The CO_2 doublet at $4{\cdot}2\,\mu$ is resolved with a scanning rate of 120 cycles per sec and a scanned interval of better than $1{\cdot}5\,\mu$ with fluorite optics. A wavelength calibrating device has been incorporated into the instrument; this presents a fiduciary scale, synchronized with the spectrum, on the 2nd beam of the twin-beam cathode-ray oscillograph. Adequate solutions have been found for the problems of synchronizing oscilloscope sweep and scanning drive, and for the problems of amplifier design for the sensitive cells. A.

535.33.072–34

939. Spectrograph with a Féry prism for the Schumann ultra-violet. A. GILLES AND B. VODAR. *J. Phys. Radium*, **11**, 513–15 (*Aug.–Sept.*, 1950) *In French.*

A brief description of a vacuum spectrograph using a LiF prism with spherical surfaces and aluminized back surface. It is intended for absorption work, and has a greater light-gathering power and gives less scattered light than a grating. The dispersion varies from 5 to 12 Å/mm in the region 1 300–1 900 Å. A. G. GAYDON

535.333 : 536.46

940. Spectrum of the glow of burning carbon. G. WHITTINGHAM. Letter in *Fuel*, **29**, 244 (*Oct.*, 1950).

Dry air was passed through a cylinder of electrode carbon at 850°C. A blue glow, which occurs when C burns at temps. > 600°C, was observed and its spectrum examined. The spectrum consists of a continuous background extending through the u.v. region, upon which faint bands are superimposed. It is believed that certain of these bands, which are strongest in the blue-green, are emitted by BO. It was confirmed that B was a major constituent of the ash of the electrode carbon used. No particular significance is attached to the BO-band emission in these experiments, since the B content of the electrode carbon used was much higher than is normally met with in solid fuels. A. SCHOFIELD

535.338

941. The spectra flames supported by fluorine. R. A. DURIE. Letter in *Proc. Phys. Soc., Lond., A*, **63**, 1292–4 (*Nov.*, 1950).

535.338.1 : 535.338.31

942. Some remarks on the analysis of the first U-spark spectrum. J. C. VAN DEN BOSCH. Letter in *Phys. Rev.*, **80**, 100 (*Oct.* 1, 1950).

A note, discussing critically various previous publications [notably that of McNally Abstr. 3925 (1950)] on the subject. J. D. CRAGGS

535.338.1 : 537.525.5

943. Determination of excitation energies of atoms with phototubes and oscillograph. L. HULDT. *Ark. Fys.*, **2**, *Paper* 33, 353–8 (1950).

Describes expts. on the simultaneous recording, with a photomultiplier/oscillograph technique, of the intensities of pairs of lines in the emission spectrum of a Hg a.c. arc lamp. If the line intensities are displayed on the x and y axes of the oscillograph screen, the curvature of the resulting line enables the relative positions of the respective upper levels in the energy level system to be found. J. D. CRAGGS

535.338.1 : 539.153

Estimation of ionization potentials by comparison with neighbouring elements. *See Abstr.* 1251

535.338.33

944. The arc and spark spectra of gadolinium. H. N. RUSSELL. *J. Opt. Soc. Amer.*, **40**, 550–75 (*Sept.*, 1950).

Analyses based on wave-numbers and intensities have led to the classification of 1 177 lines of Gd II, and 1 217 of Gd I. The percentages of the stronger lines which have been classified are respectively 77 and 90; of all lines 45 and 40. Almost all lines of astrophysical interest are included. All the identifiable terms are derived from the ground-state $^8S^\circ$ of the triply ionized atom. A complete analysis will probably be very difficult. The multiplets are remarkably regular for so high an atomic number. Intercombinations are numerous and strong, and often occur between terms differing widely in multiplicity and type. Terms of multiplicity 11 are present in Gd I and account for some of the strongest lines. A.

535.338.4

945. Band spectrum of zinc bromide. C. Ramasastry and K. Sreeramamurty. *Proc. Nat. Inst. Sci., India*, **16**, 305–9 (*July–Aug.*, 1950).

The characteristic emission band spectrum of the ZnBr molecule is recorded for the first time and it is found to consist of mainly two groups of bands, one in the near u.v. from 3 110 Å to 2 980 Å and the other in the visible. The near u.v. bands appear like diffuse lines and are analysed into two component systems, C and D, of a $^2\pi - {}^2\Sigma$ electronic transition with a $^2\pi$ width of 386 cm^{-1} and the following vibrational constants:

	(0, 0) band	ω_e''	ω_e'
System C	32 157	~ 312	~ 280
System D	32 542	~ 318	~ 350

Measurements of about 30 red-degraded bands of ZnBr from 4 500 Å to 3 600 Å are also given and a recurring interval of 130 or 260 cm^{-1} is indicated. A.

535.338.4

946. Two new $^2\Sigma - {}^2\Sigma$ systems due to the molecule NO. M. W. Feast. *Canad. J. Res. A*, **28**, 488–97 (*Sept.*, 1950).

The emission band system at 6 000 Å found in discharges in flowing NO_2 and attributed to NO^+ by Jausserant, Grillet and Duffieux has been examined at high dispersion and shown to be due to the transition of $E^2\Sigma^+$ (a new level) $\rightarrow A^2\Sigma^+$ (the upper state of the γ system) of the NO molecule. The rotational and vibrational analysis of the system is given. The band system corresponding to the transition $D^2\Sigma^+$ (upper state of the ε system of NO) $\rightarrow A^2\Sigma^+$ at 11 000 Å has also been observed and its analysis is presented. The separate nature of the $D^2\Sigma^+$ state from the $A^2\Sigma^+$ state is thus supported. Some brief remarks on other band structures found in discharges in flowing NO_2 are included. A.

535.338.4

947. The molecular spectrum of He^3. G. H. Dieke and E. S. Robinson. *Phys. Rev.*, **80**, 1–5 (*Oct.* 1, 1950).

The band spectrum of the molecule $(He^3)_2$ has been studied in the region from 3 000 Å to longer wavelengths. The present paper treats the band system $3p^3\Sigma \rightarrow 2s^3\Sigma$. The rotational and vibrational molecular constants have been determined. A.

535.338.4 : 535.371

948. Behaviour of the "blue" spectrum of benzaldehyde. H. Schüler and L. Reinebeck. *Z. Naturforsch.*, **5a**, 448–51 (*Aug.*, 1950) *In German.*

The presence of $C_6H_5 . CHO$ in C_6H_6 and certain of its derivatives is detectable from the so-called "blue spectrum" excited by a glow discharge; max. sensitivity, $1 : 10^6$. The blue spectrum is independent of the vapour pressure, and extinction coeff. and wavelength measurements indicate that it is characteristic of and due to the $-C=O$ group of the $C_6H_5 . CHO$, and not of the C_6H_5 group, as was formerly believed. A fleeting blue spectrum observed in $C_6H_5 . CH_3$ vapour under similar conditions is due to the formation of $C_6H_5 . CHO$ owing to the presence of traces of O_2. Similarities between the blue spectrum and the phosphorescence phenomena observ[ed] are used to explain the mechanism of the latter.

J. GRA[HAM]

535.343–

949. Infra-red data on epoxy structures. J. [W.] Field, J. O. Cole and D. E. Woodford. Letter [in] *J. Chem. Phys.*, **18**, 1298 (*Sept.*, 1950).

535.34[3].2 : 541.65 : 539.1[9]

Vibration spectrum of naphthalene. *See Abstr.* 12[...]

535.343.2–[...]

950. Microwave investigation of SCSe. B. Ba[...] R. Sloan and D. Williams. Letter in *Phys. Rev.* **80**, 101–2 (*Oct.* 1, 1950).

535.343.2–14 : 538.6[...]

951. Faraday effect of cm waves. C. Ryte[r] R. Lacroix and R. Extermann. *Helv. Phys. Acta* **23** (*No.* 5) 539–41 (1950) *In French.*

Preliminary experimental results on $MnSO_4 . 4H_2$[O] are described, directed to verify Kastler's suggestio[n] [see Abstr. 6905 (1949)] that the Faraday effect shoul[d] be enhanced for frequencies near the Larmor fre[-] quency. A resonance curve was observed for th[e] rotation, similar to that holding for the absorptio[n] but the maximum angle of rotation was 100 time[s] smaller than the theoretical value. The interpretatio[n] of the experimental results is complicated by variou[s] effects. L. PINCHERL[E]

535.343.2–14 : 539.133 : 539.15

952. Nuclear quadrupole frequencies in crystalli[ne] iodine compounds. H.-G. Dehmelt. *Naturwissen[-] schaften*, **37** (*No.* 17) 398 (1950) *In German.*

Following on experiments with Cl nuclei [*Natur[-] wissenschaften*, **37**, 112 (1950)] absorption frequencie[s] in the decimetre region of some homopolar iodin[e] compounds were studied. The frequencies ν_1 and ν[...] corresponding to the transitions $m_I = \pm\frac{1}{2} \leftrightarrow \pm$[...] and $\pm\frac{3}{2} \leftrightarrow \pm\frac{5}{2}$ were measured. Deviations o[f] ν_2/ν_1 from the value 2 (a measure of the deviation fro[m] axial symmetry of the electric field at the nucleus) were established. W. J. SWIATECK[I]

535.343.2–1[...]

953. Existence of electronic bands of salts of tri- and quadrivalent uranium in the infra-red spectrum in relation to the spectra of plutonium. R. Rohmer, R. Freymann, A. Chevet and P. Hamon. *C.R. Acad. Sci., Paris*, **231**, 347–9 (*July* 31, 1950) *In French.*

See Abstr. 7874 (1950). The near-infrared absorption spectra of aqueous solutions of UBr_4, UCl_3, UCl_4, UO_2Cl_2 and $UO_2(NO_3)_2$, and of solutions of UCl_4 in acetone, in ethyl acetate and in ethyl alcohol are recorded. From the time-variable spectrum of UCl_3 in H_2O and the characteristic bands of UCl_4 it appears that U III is slowly oxidized to U IV by water. Since U VI in aqueous solution exhibits no infrared absorption band it is suggested that the results of Betts and Harvey [Abstr. 536 (1949)] on Pu are due to Pu IV rather than to Pu VI. Solvent effects on the spectrum of UCl_4 are indicated. W. R. ANGUS

535.343.3–15

954. Further studies of infra-red absorption by homopolar diatomic molecules. R. Van Asselt and D. Williams. Letter in *Phys. Rev.*, **79**, 1016 (*Sept.* 15, 1950).

535.343.3–34

955. The relation of the frequency of ultraviolet absorption to the reduction potential of aromatic hydrocarbons. A. T. Watson. Letter in *J. Chem. Phys.*, **18**, 1305 (*Sept.*, 1950).

535.343.31–34

956. Observation of discrete bands in the near ultraviolet absorption spectrum of liquid ethylene. C. Reid. Letter in *J. Chem. Phys.*, **18**, 1299–300 (*Sept.*, 1950).

535.343.32–15 : 535.375.55

957. Substituted ethanes. II. Raman and infra-red spectra of 2,3-dibromo-2,3-dimethyl-butane and 2,2,3,3-tetramethylbutane. F. F. Cleveland, J. E. Lamport and R. W. Mitchell. *J. Chem. Phys.*, **18**, 1320–4 (*Oct.*, 1950).

Raman displacements and i.r. absorption wave numbers for 2, 3-dibromo-2, 3-dimethylbutane and 2, 2, 3, 3-tetramethylbutane (hexamethylethane) are reported, together with depolarization factors for the Raman lines and relative intensities for both the Raman lines and the i.r. absorption bands. The spectra were obtained in both benzene and CCl_4 solutions and the i.r. measurements covered the region 400–5 000 cm^{-1}. The results indicate that both molecules possess a centre of symmetry and that the structure is the same in the two solvents. The dipole moment of 1·01 D obtained by Mizushima, Morino and Miyagawa for 2, 3-dibromo-2, 3-dimethylbutane in CCl_4 solution may be explained by oscillations of 48° amplitude about the equilibrium transposition.

A.

535.343.4–14

958. The microwave spectrum of BrCl. D. F. Smith, M. Tidwell and D. V. P. Williams. Letter in *Phys. Rev.*, **79**, 1007–8 (*Sept.* 15, 1950).

535.343.4–15

959. The 2·7 μ-bands of carbon dioxide. R. Jones and E. E. Bell. Letter in *Phys. Rev.*, **79**, 1004 (*Sept.* 15, 1950).

535.343.4–15

960. The infra-red spectrum of chloroacetylene and deuterochloroacetylene. W. S. Richardson and J. H. Goldstein. *J. Chem. Phys.*, **18**, 1314–16 (*Oct.*, 1950).

The vapour phase i.r. spectra of the molecules HCCCl and DCCCl have been investigated in the region 2 μ to 30 μ, and 4 of the 5 fundamentals have been identified for each molecule. Force constants have been calculated for the stretching modes of vibration assuming a linear structure. The bond stretching force constants have the values: $f_{CH} = 5{\cdot}88$, $f_{CC} = 14{\cdot}9$, $f_{CCl} = 5{\cdot}51$ all in units of 10^5 dynes/cm. The effect of resonance between the covalent structure, $H - C \equiv C - Cl$, and the structure $H - C^- = C = Cl^+$ in stiffening the carbon-chlorine bond is discussed. A.

535.343.4–15

961. The intensities of several of the infra-red absorption bands of cyanogen and cyanogen chloride. E. R. Nixon and P. C. Cross. *J. Chem. Phys.*, **18**, 1316–19 (*Oct.*, 1950).

Measurement of the absolute intensities of several i.r. absorption bands of cyanogen and cyanogen chloride gives the following values in cycles per cm at N.T.P.: cyanogen, 2 150·cm^{-1} band, 90×10^{10} intensity; cyanogen chloride, 714 cm^{-1} band, 17×10^{10} intensity, 2 214 cm^{-1} band, 220×10^{10} intensity. Values of the variation in bond moments with change in bond length are calculated on the basis of bond moment additivity. This leads to widely different values of this derivative for the CN bond in the two molecules. The i.r. spectrum of cyanogen chloride from 2 to 20 microns is reported.

A.

535.343.4–15

962. The infra-red spectrum of acetylene. E. E. Bell and H. H. Nielsen. *J. Chem. Phys.*, **18**, 1382–94 (*Oct.*, 1950).

New measurements of the i.r. absorption spectrum of acetylene between 16 and 2·5 μ have established many new bands. A cooling experiment has demonstrated that the central line of the parallel band $\nu_4^1 + \nu_5^1$ (1 328·18 cm^{-1}) belongs to a difference band, $2\nu_4^0 + \nu_5^1 - \nu_4^1$ (1 328·46 cm^{-1}). Resolution sufficient to distinguish the centre of the fundamental ν_3 (3 282·5 cm^{-1}) from the combination band $\nu_2 + \nu_4^1 + \nu_5^1$ (3 295·56 cm^{-1}) has been obtained. An interesting $\Pi_u - \Pi_g$-band, identified as $\nu_1 + \nu_5^1 - \nu_4^1$, is shown. Frequencies of the i.r. inactive fundamentals are derived and many anharmonic coefficients are evaluated. Diagrams of the absorption regions and tables of the line frequencies are included. A.

535.343.4–15 : 535.375.5

963. The infra-red and Raman spectra of COClF. E. A. Jones and T. G. Burke. Letter in *J. Chem. Phys.*, **18**, 1308 (*Sept.*, 1950).

535.343.4–34

964. The ultra-violet spectrum of ethylene. W. E. Moffitt. Letter in *Proc. Phys. Soc., Lond., A*, **63**, 1292 (*Nov.*, 1950).

535.371

965. Temperature dependence of the emission of an improved manganese-activated magnesium germanate phosphor. L. Thorington. *J. Opt. Soc. Amer.*, **40**, 579–81 (*Sept.*, 1950).

An improved Mg germanate phosphor is reported here having over twice the brightness of the previous compositions as prepared in this laboratory, and which shows peak luminescence efficiency at temperatures near 350°C. A partial explanation of the pronounced temperature effect (for temperatures < 350°C) is presented and is based upon the broadening of the excitation spectrum at elevated temperatures in such a way as to increase absorption of the exciting radiation (3 650 Å). Data are presented showing differences in the temperature dependence relation effected by wavelength of excitation and method of measurement; in addition, curves are included showing the variation of phosphorescence ($t = 1/120$ sec) with temperature as well as curves showing excitation and emission characteristics of the phosphor. Finally a practical application of this high temperature luminescence is demonstrated in the colour-corrected, high-pressure Hg lamps, the emission characteristics of which are briefly discussed. A.

535.371

966. Separation of spectra in adjacent surface layers of phosphorescent bodies of variable composition. B. Prégel. *C.R. Acad. Sci., Paris*, **231**, 898–9 (*Oct.* 30, 1950) *In French.*

Continuation of earlier work [Abstr. 215 (1951)].

S. T. HENDERSON

535.371

967. Influence of the state of oxidation of the luminescence centres on the colour of luminescence of zinc sulphide activated by copper. E. Grillot and M. Bancie-Grillot. *C.R. Acad. Sci., Paris*, **231**, 966–8 (*Nov.* 6, 1950) *In French.*

The luminescence varies from blue-violet when calcination is effected in complete absence of O, to green when some oxidation is permitted.

S. T. HENDERSON

535.371

968. The luminescence of diamonds. C. Bull and G. F. J. Garlick. *Proc. Phys. Soc., Lond., A*, **63**, 1283–91 (*Nov.*, 1950).

Studies of the luminescence characteristics of different types of industrial diamonds (80–100 mesh dust) have been made. Blue fluorescent diamonds (3 650 Å exciting radiation) exhibit thermoluminescence characteristics of two groups of metastable electronic states, with mean activation energies of 0·5 and 0·7 eV respectively. Transitions of a forbidden nature from these states to the normal states of emission centres give rise to a temperature-independent, green-yellow phosphorescence, whose longest-lived component has a decay constant of 2×10^{-5} sec^{-1}. Most yellow luminescent and non-luminescent diamonds (3 650 Å exciting radiation) exhibit a blue luminescence when excited by energetic particles or by X-rays, but no thermoluminescence is observed after any type of excitation. The luminescence of diamonds appears to be characteristic of the matrix crystal, and a tentative model for the emission centres is given. A.

535.371 : 548.0

969. The luminescence of diamond and its relation to crystal structure. C. V. Raman and A. Jayaraman. *Proc. Indian Acad. Sci. A*, **32**, 65–73 (*Aug.*, 1950).

The relationships between luminescence birefringence are described and illustrated in the paper by a new series of photographs obtained with improved technique and with diamonds of the first quality. It is shown that the results fully support the conclusions reached earlier, viz. that the luminescence of diamond has a structural origin. It is also pointed out that the classification of diamond into two species as Type I and Type II does not correspond with reality and must therefore be discarded. A.

535.371 : 621.385.832

970. Saturation of fluorescence in television tubes. A. Bril and F. A. Kröger. *Philips Tech. Rev.*, **12**, 120–8 (*Oct.*, 1950).

In the case where phosphors are brought to fluorescence by excitation with electrons, when a high current density is reached in the electron beam the efficiency of the fluorescence decreases. This is due to the number of activator centres present in the crystal lattice being limited. This "saturation" of the fluorescence appears, in the case of continuous bombardment with electrons, to depend both upon the activator concentration and upon the average life time of the excited activators. In the case of discontinuous irradiation, as takes place when the screen of a television tube is scanned with an electron beam, there is no longer any dependency upon the average lifetime of the activators if that lifetime is shorter than the interval between two successive passages and longer than the time the electron beam takes to scan a certain spot. A comparison of the properties of silicate phosphors and sulphide phosphors shows that it is advantageous to use sulphide phosphors in tubes in which not too large current densities occur, whilst in tubes with a heavy load on the fluorescent screen silicate phosphors are to be preferred, notwithstanding the fact that as a rule their efficiency is less than that of sulphide phosphors. In order to avoid a change in colour under a high current density when using a white-fluorescing mixture of two phosphors, the characteristics of the two components must be uniform. Possibilities are discussed for matching the characteristics of the components one with the other. Even when a mixture with uniform characteristics is used colour-changing may still occur when the beam is defocused. A.

535.37

971. On the fluorescence and phosphorescence emission spectra of manganese-activated zinc silicate. J. H. Schulman and C. C. Klick. Letter in *J. Opt. Soc. Amer.*, **40**, 622–3 (*Sept.*, 1950).

535.37

972. The absorption spectrum of CF_2. R. K. Laird, E. B. Andrews and R. F. Barrow. *Trans. Faraday Soc.*, **46**, 803–5 (*Oct.*, 1950).

Some of the ultra-violet bands of CF_2 have been observed in absorption. Qualitative study of the decay in intensity of absorption with time suggests that CF_2 has a half-life of the order of 1 sec under the conditions of the experiment. A.

535.37

973. A Coriolis perturbation in the ultra-violet spectrum of formaldehyde. J. C. D. Brand. *Trans. Faraday Soc.*, **46**, 805–12 (*Oct.*, 1950).

The rotational structure of the principal progression of bands in the fluorescence spectrum of formaldehyde is affected by Coriolis coupling between the fundamental vibrations ν_5 and ν_6 in the levels of the electronic ground state. This coupling is strong between the fundamental frequencies, but is progressively much diminished between the combination levels $\nu_2+\nu_5$ and $\nu_2+\nu_6$, $2\nu_2+\nu_5$ and $2\nu_2+\nu_6$, etc. Approximate values of the coupling parameter have been evaluated. In this group of bands the electric moment is perpendicular to the symmetry axis, in the plane of the molecule. A.

535.37

974. Fluorescence studies of some simple benzene derivatives in the near ultraviolet. II. Toluene and benzonitrile. A. M. Bass. *J. Chem. Phys.*, **18**, 1403–10 (*Oct.*, 1950).

The fluorescence spectra of toluene and benzonitrile have been studied using various sources of excitation. In both cases, discrete spectra have been

observed in the near ultraviolet. The spectrum of toluene shows about 100 bands while that of benzonitrile shows about 140 bands. In both cases, there is good agreement with the absorption spectra. Progressions are noted and assignments are made for some of the vibrations in accordance with the symmetry properties of the molecules. A.

535.375.5

975. Raman spectra and normal coordinate treatment of methylchlorosilanes. T. SHIMANOUCHI, I. TSUCHIYA AND Y. MIKAWA. Letter in *J. Chem. Phys.*, **18,** 1306 (*Sept.*, 1950).

535.375.5

976. The Raman spectra of ethylchlorosilanes. H. MURATA, R. OKAWARA AND T. WATASE. Letter in *J. Chem. Phys.*, **18,** 1308–9 (*Sept.*, 1950).

535.375.54

977. Raman spectrum of cadium tungstate. V. CHANDRASEKHARAN. Letter in *Curr. Sci.*, **19,** 277 (*Sept.*, 1950).

535.375.54 : 536.631

978. On the Raman spectra and heat capacity of benzene at low temperatures. S. C. SIRKAR AND A. K. RAY. *Indian J. Phys.*, **24,** 189–96 (*May*, 1950).

535.375.54 : 548.0

979. Variation of frequency of Raman lines with the direction of propagation of elastic waves in the crystal. L. COUTURE-MATHIEU AND J.-P. MATHIEU. *C.R. Acad. Sci., Paris*, **231,** 839–41 (*Oct.* 23, 1950) *In French.*

Raman spectra of a crystal of iodic acid taken with the polarized incident light entering the crystal along different axes, contain corresponding lines which differ in frequency and intensity according to the direction. These varying frequencies are associated with vibrations in which a dipole moment is produced. It is concluded that the frequency of the elastic waves producing a dipole moment depends upon their direction of propagation. A. C. MENZIES

535.375.54 : 548.0

980. Vibration frequencies of hydrated ions. J.-P. MATHIEU. *C.R. Acad. Sci., Paris*, **231,** 896–7 (*Oct.* 30, 1950) *In French.*

By studying Raman spectra of single crystals of hydrated salts, as well as solutions, it is shown that a wide, polarized Raman line of about 380 cm^{-1} is due to hydrated cations of the form $Me(OH_2)_6$. The frequency for the total-symmetric vibration of $Mg(OH_2)_6$ is calculated and found to be in close agreement with that observed. A. C. MENZIES

535.375.54 : 548.7

981. Raman spectrum of anhydrite. R. S. KRISHNAN AND C. S. KUMARI. *Proc. Indian Acad. Sci., A*, **32,** 105–9 (*Aug.*, 1950).

Using λ2536·5 Hg resonance radiation as exciter, the Raman spectrum of a single crystal of anhydrite has been investigated for 3 different orientations. Besides the 9 Raman lines due to the sulphate ion, the recorded spectrum exhibits 8 of the 9 lattice lines to be expected theoretically. Their frequency shifts are 62, 126, 135, 151, 169, 184, 233 and 262 cm^{-1}. From the observed variations in intensity with orientation, tentative assignments have been given to the lattice lines. A.

535.375.54 : 548.7

982. Raman spectrum of potassium chlorate and its temperature variation. C. S. KUMARI. *Proc. Indian Acad. Sci., A*, **32,** 177–83 (*Sept.*, 1950).

Using the λ2537 radiation of mercury arc as exciter, the Raman spectrum of a single crystal of $KClO_3$ has been photographed. The spectrum exhibits 10 Raman lines of which 4 lattice lines 54, 82, 98 and 145 cm^{-1} have been recorded for the first time. The variations in the position and width of the prominent Raman lines have been studied at ten different temperatures ranging from 90° to 603°K. The value of the proportional change is found to be different for different Raman lines and is higher at higher temperatures. No change in the crystal symmetry is noticed throughout the temperature range investigated. A.

535.375.54 : 548.7

983. Raman spectra of crystalline tartrates. IV. Sodium ammonium tartrate. V. M. PADMANABHAN. *Proc. Indian Acad. Sci., A*, **32,** 184–6 (*Sept.*, 1950).

Using λ2537 resonance radiation as exciter, the Raman spectrum of crystalline sodium ammonium tartrate has been recorded for the first time. The spectrum exhibits 33 Raman lines. The observed frequency shifts are compared with those of ammonium tartrate and sodium tartrate. The internal frequencies of the NH_4 ion are found to be suppressed in the spectrum of the mixed tratrate. A.

535.375.54 : 548.7

984. Raman spectrum and structure of acid potassium carbonate. L. COUTURE-MATHIEU. *J. Phys. Radium*, **11,** 541–8 (*Oct.*, 1950) *In French.*

The Raman spectrum of a single crystal of $KHCO_3$ points to the linkage of CO_3 ions with one another by H bonds. The study of the internal vibrations of the CO_3 ions suggests an orientation of these ions in the lattice, and an approximate structure of the crystal. The H bonds lower the symmetry of the CO_3 ion and bring about broadenings of the Raman lines corresponding to internal vibrations, which are in some cases considerable. The Raman spectrum of this salt, whose structure is hitherto unknown, is similar to that of $NaHCO_3$, whose structure is already known from X-rays and does contain H bonds linking the CO_3 ions. A. C. MENZIES

535.376

985. Scintillation efficiency of anthracene crystals. J. B. BIRKS. Letter in *Proc. Phys. Soc., Lond., A*, **63,** 1294–5 (*Nov.*, 1950).

535.39

986. The application of quadripole theory to the Maxwell equations. W. HÜBNER. *Optik*, **7** (*No.* 3) 128–46 (1950) *In German.*

The methods of quadripole theory as used in electrical problems are outlined. Similar methods are used to calculate the reflection of electromagnetic waves at a plane boundary, and the parallelism of certain quantities in the two cases is emphasized. Reflection of light at a surface coated with a double film designed to increase or decrease reflection is considered. G. F. LOTHIAN

535.39

987. A method for the determination of optical constants of semi-transparent films. M. S. OLDHAM, L. G. MUNDIE, F. MATOSSI AND B. F. CHEYDLEUR. Letter in *J. Opt. Soc. Amer.*, **40**, 544 (*Aug.*, 1950).

The film thickness s, reflectance at 10° angle of incidence $R_{\perp 10}$ and transmittance at normal incidence $T_{\perp 0}$ are measured experimentally, and n_2 and k_2 are then obtained from the equations presented by Hadley and Dennison [Abstr. 2519 (1947)]. A numerical solution of these equations is found with the aid of IBM machines. C. TURNER

535.39 : 535.321 : 531.715.1

988. On the simultaneous determination of the optical constants and the thickness of very thin metallic films. F. ABELÈS. *C.R. Acad. Sci., Paris*, **231**, 958–60 (*Nov.* 6, 1950) *In French.*

For extremely thin films an approximation can be used permitting development of an expansion series in the theory formerly developed for the optical characteristics of thin films. It is shown that the reflectivities measured respectively from both sides of the film and the transmission are related. Further, it is shown how both thickness and optical constants can be derived in terms of transmissions, absorptions and the refractive indices of the media on either side of the thin film. S. TOLANSKY

535.39 : 535.321 : 531.715.1

989. A method of determining concurrently the thickness and refractive index of a thin film or lamina. P. D. FOCHS. Letter in *J. Opt. Soc. Amer.*, **40**, 623 (*Sept.*, 1950).

535.41

990. Light beats. M. v. LAUE. *Optik*, **7** (*No.* 3) 125–7 (1950) *In German.*

Reasons are given showing that there is no effective difference between light interference and light beats, which can both be produced by sharp monochromatic lines and by a section of a continuum. Relativistic considerations are applied and as transformations can lead to frequency alterations the identity of the two sets of phenomena is established. The absence of beats in the Zeeman effect is shown to be due to incoherence. S. TOLANSKY

535.417

991. Multiple-beam interferometry. S. TOLANSKY. *Endeavour*, **9**, 196–202 (*Oct.*, 1950).

An account is given of the application of multiple-beam interferometry to the study of metals, surface polish, hardness testing, and formation of slip-bands in stressed metallic crystals. The technique is also used in studying the mechanism of crystal growth in certain minerals, the hardness anisotropy of diamond undergoing abrasion tests, and the modes of oscillation of quartz. A new method of obtaining sharp fringes and the adaptation of an older method for examining defects in mica are described.

535.417 : 531.715.15

992. Improving the quality and the testing of optical flats. E. EINSPORN. *Optik*, **7** (*No.* 3) 147–68 (1950) *In German.*

A discussion of the evaluation of slight curvature of optical flats by means of Fizeau fringes. The method is shown to be comparable to that using Haidinger fringes. A discussion is included on the effect combining slightly curved flats. S. TOLANSK

535.4

993. The theory of diffraction by a screen. V FRANZ. *Z. Phys.*, **128** (*No.* 3) 432–41 (1950) *German.*

Shows how the problem of calculating the diffracti round a curved screen with sharp edges can be state in terms of definite integrals. The treatment is base on the electromagnetic theory of light, and t electric vectors parallel and normal to the surfa are considered separately. N. CORCORA

535.421 : 539.23

Two improved methods of graticule production usin evaporated metal films. *See Abstr.* 1348

535.54

994. On sensitive color. H. KUBOTA. Letter i *J. Opt. Soc. Amer.*, **40**, 621 (*Sept.*, 1950).

The author considers two parallel Nicols with a thi crystal between and shows that the colour sensitivit (defined as the rate of change of colour with variatio of retardation) is greater in this case than in the mo usual arrangement of two crossed Nicols. This on holds good when the deviation of the axis of th crystal from the diagonal position is less than 5°. N. CORCORA

535.5

995. Structural birefringence in amorphous solid C. V. RAMAN. *Proc. Indian Acad. Sci., A*, **31**, 207–1 (*April*, 1950).

The result reported in an earlier investigation wit vitreous silica is now shown to be true also for othe amorphous solids, including especially inorgani glasses; besides the well-known photo-elastic effect another kind of birefringence may be observe differing from the former both in its origins and i its observable characters. This "structural bire fringence" arises from anisotropy of structure presen in the solid by reason of the circumstances of it formation. It is conspicuously seen with plate glas whose optical behaviour shows it to have a highl laminated structure, while in moulded glass, it exhibit itself as luminous streaks or sheets of variously curved forms. A

535.55 : 541.18

Streaming birefringence of polystyrene in solution *See Abstr.* 1439

535.55 : 548.0

996. Photo-elasticity of diamond. G. N. RAMA-CHANDRAN. *Proc. Indian Acad. Sci., A*, **32**, 171–3 (*Sept.*, 1950).

The photo-elastic constants of diamonds have been redetermined and are found to be $q_{11} = -5{\cdot}0_5$, $q_{12} = +2{\cdot}1_5$, $q_{44} = -2{\cdot}8\times10^{-14}$ cm² dyne^{-1} and $p_{11} = -0{\cdot}31$, $p_{12} = +0{\cdot}09$, $p_{44} = -0{\cdot}12$. These lead to a decrease in refractive index when diamond is subjected to a hydrostatic pressure. A.

535.617

997. The physical foundation of a colour circle and propositions of a physical theory of colour. H. WOLTER. *Ann. Phys., Lpz.*, **8** (*No.* 1–2) 11–29 (1950) *In German.*

A periodic stencil is moved through the spectrum to produce a physical colour circle. A Fourier series provides expressions for standard colours (s.c.).

The resultant circle is similar to Ostwald's if saturated s.c.'s are used. All the possible loci are given by ellipses. Three constants, characterizing every s.c., can be determined with an improved pocket spectrometer to an accuracy of "a few per cent." Diagrams are given. R. A. WEALE

535.617

998. The colour triangle. W. DE GROOT AND A. A. KRUITHOF. *Philips Tech. Rev.*, **12**, 137–44 (*Nov.*, 1950).

In analogy with the conception of luminance (objective brightness) the conception of colour is dealt with. A brief explanation is given of the construction of the colour space in *XYZ* co-ordinates (I.C.I. 1931) and of the corresponding chromaticity diagram, the possibility of rendering of the colour plane with the aid of oil paints being then discussed. A reproduction is appended. Finally the number of chromaticities is proved to exceed 10 000 and reference is made to the difference between the conceptions of "colour stimulus" and "colour sensation." A.

535.617

999. The colour triangle. W. DE GROOT AND A. A. KRUITHOF. *Ned. Tijdschr. Natuurkde.*, **16**, 235–41 (*Oct.* 1950) *In Dutch.*

A short survey of the theory of the colour triangle, with a description of a device consisting of three colour filters, a triangular screen and a triangular diaphragm, with which the colour triangle can be realized. C. TURNER

535.64

1000. Loci of constant hue and brightness determined with various surrounding colors. D. L. MACADAM. *J. Opt. Soc. Amer.*, **40**, 589–95 (*Sept.*, 1950).

All colours which evoke the same hue and brightness are represented by a curve in the chromaticity diagram and have lower luminances for high saturations than for low. The various loci tend to converge on a point which represents an acceptable white under the conditions of adaptation produced by the surrounding colour. The influence on adaptation of surrounding colour beyond a 10-degree test field is of the same order of magnitude as the influence of the colour of the comparison half of the test field. A.

535.642

1001. Graphical method for synthesis and resolution of luminous colour mixtures. V. A. BABITS. *Optik*, **7** (*No.* 3) 172–80 (1950).

Describes a geometrical construction for finding the point on the colour triangle which corresponds to a mixture in specified proportions of two or more component lights similarly represented. A method for the reverse operation, i.e. determination of the components of a given compound light, is also given. J. W. T. WALSH

535.65

1002. Measurement of small color differences in tomato purees. S. G. YOUNKIN. *J. Opt. Soc. Amer.*, **40**, 596–9 (*Sept.*, 1950).

A method is described in which puree colours are measured with a Hunter Color-Difference Meter. Specifications are interpreted on a chromaticity diagram showing location of Munsell constant hue and chroma lines at a lightness level intermediate for most tomato purees. Appearance as interpreted from the chromaticity diagrams was in nearly perfect agreement with appearance scored on a visual basis. A.

535.8

1003. Two dimensional coloured Schlieren apparatus. H. WOLTER. *Ann. Phys., Lpz.*, **8** (*No.* 1–2) 1–10 (1950) *In German.*

The conventional Schlieren system, recording only brightness, is affected only by the components of deflection at right angles to the knife-edge. With a coloured Schlieren system, using an illuminated colour circle in place of the slit and a circular aperture in place of the knife-edge, the hue and saturation of an image will indicate the direction and magnitude of the deflection. Applications to microscopy and methods of making the colour circle are described. Colour plates illustrate Schliere in glass blanks and the growth of crystals. R. W. FISH

535.8 : 535.31

1004. The concept of a perfect optical instrument. F. BLOTTIAU. *Rev. Opt.* (*Théor. Instrum.*) **29**, 563–79 (*Nov.*, 1950) *In French.*

An optical system which closely approaches the Gaussian laws of image formation may still yield a distorted image of a three-dimensional object if the perspective is rendered incorrectly. Conditions for an undistorted image are derived and some thin lens systems described which possess this property for the observation of near objects. Some systems employing photographs as intermediaries are also considered. R. W. FISH

535.81 : 771.35

1005. Stray light characteristics of photographic objectives. O. MACEK AND A. KRUIS. *Z. angew. Phys.*, **2** (*No.* 9) 359–62 (1950) *In German.*

The stray light formed by a photographic lens with an incident parallel beam is measured by an electron multiplier system at varying angles from the geometric image. Results are given for a triplet lens before and after blooming and with dirty surfaces. These show that between 5° and 60° from the image, a bloomed lens has a straight line relationship between the stray light and angle. The effect of Rayleigh scattering is small and is not necessarily reduced by blooming. R. W. FISH

535.822.6

1006. An equipment for the microscopic examination of metals and crystals in polarized light at temperatures from — 130 to + 35°C. J. C. MONIER AND R. J. HOCART. *J. Sci. Instrum.*, **27**, 302 (*Nov.*, 1950).

An easily constructed apparatus for use with a metallurgical polarizing microscope provides for the examination of specimens between + 35 and — 130°C. No ice is deposited either on the lenses or on the specimen, which can be examined in the ordinary way. A.

535.822.9

1007. An extension of Toraldo's theory of phase contrast. II. L. I. EPSTEIN AND D. R. HERRIOTT. *J. Opt. Soc. Amer.*, **40**, 576–8 (*Sept.*, 1950).

See Abstr. 6431 (1950) for first part. Some of the light intensity distributions calculated in the first paper

of this series have been observed experimentally with the aid of a macroscopic set-up. Because of a peculiarity of the human eye, a degree of contrast which is far from optimum will be satisfactory for practical purposes. The theoretical investigation begun in the first paper is continued. A measure of contrast is defined by analogy to Michelson's measure of visibility of fringes. An expression for this is derived for the case of a very narrow phase annulus filled with light except for a narrow zone along each edge. The possibility of measuring the phase shift introduced by an object, with the aid of phase contrast equipment, is discussed. A.

HEAT 536

536.2.083

1008. Technical apparatus for determining thermal conductivity of steels up to 500°C. Z. HORÁK AND F. KRUPKA. *Rev. Sci. Instrum.*, **21**, 827–30 (*Oct.*, 1950).

An apparatus based upon the comparison of flux of heat in a conductor in the usual form of a bar consisting of 3 parts of different materials has been developed. This method enables one to measure the temperature gradients by only one differential thermocouple sliding in an axial boring of the bar. In this way usually difficult measurements of thermal conductivity can be carried out very easily with sufficient accuracy for industrial purposes. A.

536.212

1009. Heat conduction in a segment of a cylinder. V. VODICKA. *Schweiz. Arch. angew. Wiss. Tech.*, **16**, 304–8 (*Oct.*, 1950) *In German.*

Mathematical. The differential equation for the temperature distribution for a cylinder of circular cross-section is solved using the complex variable and the Laplace transformation. S. WEINTROUB

536.212.2/3 : 536.48

1010. The thermal conductivity of Chroman B 2 Mo at low temperatures. F. SCHMEISSNER AND H. MEISSNER. *Z. angew. Phys.*, **2**, 423–4 (*Oct.*, 1950) *In German.*

Chroman B 2 Mo is an alloy of percentage composition (by weight) 61·4 Ni, 18·5 Cr, 14·5 Fe, 3·0 Mn, 2·0 Mo, 0·6 Si. Similar alloys have been found to be extremely good thermal insulators at low temps., but their practical application has been limited by the fact that they cannot be manufactured in the form of thin-walled tubes. Chroman B 2 Mo can be used for this purpose. Its thermal conductivity was measured by recording the heat (in the form of electrical energy) needed to maintain a const. temp. difference between the two ends of a sample in the form of a softened sheet 0·1 mm thick. Values obtained ranged from 0·12 watt/cm °K at 88°K to 0·0026 watt/cm °K at 3·9°K. Chroman B 2 Mo is thus a good thermal insulator at low temps. The accuracy of measurement is estimated as 2%, but it is pointed out that the thermal conductivity depends very greatly upon the mechanical and thermal pretreatment of the specimen. The specific resistance of the alloy was also measured; this varies gradually from $1{\cdot}02\times10^{-4}$ ohm cm at 4·2°K to $1{\cdot}08\times10^{-4}$ ohm cm at 90°K. A. SCHOFIELD

536.24

1011. Heat conduction in laminated spherical and cylindrical bodies. V. VODICKA. *Schweiz. Arch. angew. Wiss. Tech.*, **16**, 297–304 (*Oct.*, 1950) *In German.*

The differential equations for the temperature distribution in the two types of bodies are formulated and solved. S. WEINTROUB

536.46 : 531.57

1012. The rate of burning of powders at pressures up to 10 000 kg/cm². JAC. BASSET AND JAM. BASSET. *C.R. Acad. Sci., Paris*, **231**, 649–51 (*Oct.* 2, 1950) *In French.*

A stick of propellant 3·5 mm dia. and 50 mm long was burned in a large closed vessel; burning was inhibited on the curved sides of the stick by a layer of varnish, and the rate of burning along the length was measured by recording the time between the melting of two fine Pb wires inserted a known distance apart along the stick. Before igniting the propellant the combustion vessel was filled with N or A at approx. the pressure under examination; while the propellant stick burned the pressure increased, but only by 3 to 10%. For a series of smokeless propellants containing varying proportions of nitrocellulose, nitroglycerine and centralite it was found that the rate of burning (V) varies non-linearly with the pressure (P) below approx. 1 000 kg/cm²: this is at variance with a formula due to Muraour which expresses V in the form $\alpha + \beta P$ where α and β are constants for a particular propellant. Over the range 1 000 to 10 000 kg/cm² Muraour's formula was found to be valid for all the propellants tested. A. SCHOFIELD

536.462

1013. A spectrophotometric determination of exhaust gas temperatures in the pulse-jet engine. H. F. QUINN. *Canad. J. Res. A*, **28**, 411–32 (*July*, 1950).

A method whereby instantaneous values of a variable flame temperature, in the particular case of non-luminous flames, may be determined and continuously recorded. This new technique, which depends upon the establishment of monochromatic black-body radiation conditions in the flame for a small region in the visible spectrum, involves the continuous measurement of radiation intensity in the above region, the intensity being, thereafter, correlated with the temperature of the flame. The problem of temperature measurement in the general case of non-luminous flames is considered and a brief review of previous techniques employed for this purpose over the past 50 years is given. The basic theory and preliminary experimental justification of the present method are discussed. Details are given of a special type of spectrophotometer which employs a multiplier photocell as the radiation detecting and measuring element and, also, a "black-body" cavity constructed as a standard radiation source for the calibration of the former instrument. Finally, the measurable temperature range of the present apparatus is considered together with the inherent limitations of the new method. A.

536.468

1014. The composition limit of flame propagation. II. Y. Fujisaki and H. Yamamura. *J. Sci. Hiroshima Univ.*, **14**, 159–63 (*March*, 1950).

An experimental investigation of flame-propagation in H_2–O_2 and C_2H_2–O_2 mixtures, using the technique described in an earlier paper [Abstr. 7201 (1950)]. It was found that addition of CO_2 and N_2 to the H_2–O_2 mixture narrows the limits of flame propagation: the effect of these diluents is more pronounced at the upper limit than at the lower, and the limits are more affected by addition of CO_2 than N_2. The limits of flame propagation are also narrowed by coating the inside of the explosion tube with KCl, the upper limit being more sensitive than the lower. These observations are explained in terms of Hinshelwood's chain reaction for the H_2–O_2 flame. For C_2H_2–O_2 mixtures the influence of igniting source and tube length upon the limits of propagation was examined. It was found that a detonating mixture of $C_2H_2 + 3O_2$ was a more effective initiator than $H_2 + O_2$; this is attributed partly to the greater strength of the shock-wave generated by the $C_2H_2 + 3O_2$ initiator, and partly to the fact that free radicals to start the C_2H_2–O_2 reaction are available from this type of initiator, and not from $H_2 + O_2$. Increase in tube length greatly narrows the limits of flame propagation of C_2H_2–O_2 mixtures; for example, with an explosion tube 100 cm long the limits are 3–31% C_2H_2 with an $H_2 + O_2$ initiator, but if the length is increased to approx. 250 cm these limits narrow to 15–20% C_2H_2. A. SCHOFIELD

536.48

1015. Transport rates of the liquid He II film over various surfaces. H. A. Boorse and J. G. Dash. Letter in *Phys. Rev.*, **79**, 1008 (*Sept.* 15, 1950).

536.48

1016. Superfluidity and thermomechanical effect in the adsorbed helium II film. E. Long and L. Meyer. Letter in *Phys. Rev.*, **79**, 1031–2 (*Sept.* 15, 1950).

536.48

1017. The velocity of second sound below 1°K. K. R. Atkins and D. V. Osborne. *Phil. Mag.*, **41**, 1078–81 (*Oct.*, 1950).

Extension of the measurements of Pellam and Scott [Abstr. 1712 (1950)] to lower and more accurately measured temperatures. The velocity rises to 152 ± 5 m/sec at 0·1°K. This agrees with Landau's prediction that at 0°K the velocity of second sound = velocity of ordinary sound/$\sqrt{3}$. In agreement with Abstr. 1712 (1950) the received pulse is considerably distorted and lengthened at low temperatures. H. LONDON

536.48

1018. The velocity of flow of helium II in the creeping film. L. C. Jackson and D. G. Henshaw. *Phil. Mag.*, **41**, 1081–4 (*Oct.*, 1950).

The measurements of film thickness on a stainless steel covered with a monolayer of Ba stearate by Jackson and Burge [Abstr. 1721 (1950)] are extended to moving films and the creep rates are measured simultaneously. The latter are of the same order of magnitude as those of Mendelssohn and White [*Nature*, **166**, 127 (1950)] on Pt, considerably larger than on glass, but of the type characteristic for a clean surface. The thickness 1 cm above the liquid level ranges from $1{\cdot}63\times10^{-6}$ to $1{\cdot}94\times10^{-6}$ cm and the mean velocity from 72 to 29 cm/sec in the temperature range from 1·1 to 1·9°K. The increased flow rate observed initially with nearly full beakers is associated with the appearance of bright specks moving downwards with a velocity of only ~ 1 cm/sec, which are interpreted as "drops" of liquid He. H. LONDON

536.48 : 536.7

1019. The thermodynamics of liquid helium of He^3–He^4 solutions. O. K. Rice. Letter in *Phys. Rev.*, **79**, 1024–5 (*Sept.* 15, 1950).

Assuming either zero enthalpy or zero entropy of mixing of normal and super-fluid in pure He^4, and making several different assumptions on the value of the total entropy divided by the concentration of the normal fluid, the dependence of the λ-point on the concentration of He^3 in He^3–He^4 solutions resulting in each case is calculated. H. LONDON

536.48 : 537.226.2

1020. The dielectric constant of liquid helium. C. J. Grebenkemper and J. P. Hagen. Letter in *Phys. Rev.*, **80**, 89 (*Oct.* 1, 1950).

536.48 : 539.154

1021. Atomic heat of indium at liquid helium temperatures. J. R. Clement and E. H. Quinnell. Letter in *Phys. Rev.*, **79**, 1028 (*Sept.* 15, 1950).

536.521 : 535.233/234

1022. Two nomograms for use in measurements with optical pyrometers. J. Euler and R. Ludwig. *Z. angew. Phys.*, **2** (*No.* 2) 362–6 (1950) *In German.*

Temperature measurement with optical pyrometers depends on the emissivity of the heated object. The relation between true temperature and blackbody temperature is discussed and nomograms based on the Planck and Wien formulae are deduced and illustrated. A knowledge of one absorption coefficient and two blackbody temperature-wavelength points is necessary. E. H. DOCK

536.58

1023. Precision thermostat for high temperatures. W. R. Eubank. *Rev. Sci. Instrum.*, **21**, 845–51 (*Oct.*, 1950).

Temperatures (1 000°–1 550°c) are readily maintained constant within ± 0·1°c for several hours, and within ± 1·0°c for several days. In this method of control a thyratron is used in conjunction with an a.c. bridge and high gain amplifier. The phase angle of the unbalanced bridge regulates the firing of the thyratron. The control is highly sensitive and independent of normal fluctuations in line voltage. The thermostat is convenient to operate, easy to adjust for any temperature, and reliable for periods of continuous operation from a few minutes to several days. A.

536.628.2 : 541.183.56

1024. The measurement of the thermal properties of gases and vapours adsorbed on solid surfaces. J. A. Morrison and J. M. Los. *Disc. Faraday Soc.*, *No.* 8, 321–6 (1950).

A description is given of a low-temperature adia-

batic calorimeter suitable for the measurement of thermal properties of gases and vapours adsorbed on solid surfaces. The calorimeter was designed particularly for the determination of the heat capacity and the heat of adsorption of adsorbed films with rather high precision. A.

THERMODYNAMICS 536.7/.8

536.7

1025. Onsager's principle. J. E. VERSCHAFFELT. *Bull. Acad. Roy. Belge Cl. Sci.*, **36** (*No.* 7) 548–60 (1950) *In French.*

A reply to de Groot's criticism of the author's theory [Abstr. 8718 (1950)]. Verschaffelt claims that Onsager's principle is no more fundamental than his own, and that a complex irreversible process may justifiably be divided into a number of simple processes in any desired manner, so long as the total entropy change is correctly given. It is further claimed that Verschaffelt's treatment takes due account of the coupling of chemical reactions.

N. CORCORAN

536.7

1026. Thermodynamic properties of isotopic compounds of sulphur. A. P. TUDGE AND H. G. THODE. *Canad. J. Res. B*, **28**, 567–78 (*Sept.*, 1950).

Using the well known methods of statistical mechanics, partition function ratios for many isotopic S compounds have been calculated. These partition function ratios are used to determine equilibrium constants for many possible exchange reactions involving the isotopes of S. The results indicate that considerable fractionation of the S isotopes can be expected in laboratory and natural occurring processes. The predicted exchange constants are discussed in the light of recent results on the distribution of the S isotopes in nature. A.

536.712

1027. The isothermals of rocksalt from its thermal expansion. B. DAYAL. Letter in *J. Chem. Phys.*, **18**, 1302–3 (*Sept.*, 1950).

536.75

1028. Ophélimité and entropy. A. PIKLER. *Scientia*, **85** (*No.* 10) 257–60 (1950) *In French.*

A discussion of the analogy between the concept of utility (sometimes termed ophélimité) in economics and that of entropy in thermodynamics.

F. E. HOARE

536.791

1029. The Nernst heat theorem and the behaviour of the ratio of the specific heats of gases in the neighbourhood of the absolute zero. K. POPOFF. *C.R. Acad. Sci., Paris*, **231**, 686–7 (*Oct.* 9, 1950) *In French.*

By Nernst's theorem lim. $c_p = c_v = 0$ as $T \to 0$. A gas obeying equation $pv = RT$ does not satisfy this relation. Writing $pv = RT^{(1+\alpha)}$ it follows that $c_p - c_v = R(1 + \alpha)^2 T^{\alpha}$ which gives the correct limiting value. See also Abstr. 4747 (1949).

F. E. HOARE

ELECTRICITY 537

ELECTROSTATICS . DIELECTRICS 537.2

537.2 : 536.6

1030. Energy in electrostatics. W. B. SMITH-WHITE. Letter in *Nature, Lond.*, **166**, 689–90 (*Oct.* 21, 1950).

Criticism of Guggenheim's expression for the work done in a small change in a system of dielectrics. Another expression is suggested, from which the formulae of Larmor and Livens for the stress on a dielectric may be deduced. Equations expressing the first law of thermodynamics for solid and fluid dielectrics have been obtained. S. MICHAELSON

537.21 : 530.145.6

1031. Quantum limits of the electrostatic image force theory. R. G. SACHS AND D. L. DEXTER. *J. Appl. Phys.*, **21**, 1304–8 (*Dec.*, 1950).

The quantum mechanical problem of the interaction of a charged macroscopic body with a metal surface is treated by means of the variation method. The resulting expression for the interaction energy is the same as that obtained by the classical image force method except for three correction terms. These corrections are caused by the change in kinetic energy associated with the concentration of the electrons on the surface of the metal, the reduction in the electron-electron interaction energy in the metal resulting from the anti-symmetrization of the wave function and the effect of the finite thickness of the surface charge. It is found that these terms are negligible except for distances between the charged body and metal surface such that surface structure effects are important. A.

537.221

1032. Investigation of oxidation and corrosion processes on metal surfaces by the measurement of contact potentials. H. NEUERT AND H. HÄNSEL. *Z. angew. Phys.*, **2** (*No.* 8) 319–23 (1950) *In German.*

The time-variation of contact potential was measured by Kelvin's method for Al, Zn, Fe, Pb and Duralumin, and characteristic variations were found. In this way the corrosion and oxidation of metals in gases and vapours were investigated, and a logarithmic law of oxide growth was confirmed.

F. LL. JONES

537.221

1033. Contact potentials of evaporated iron films in air and in nitrogen at low pressure. N. HACKERMAN AND L. L. ANTES. *Science*, **112**, 471 (*Oct.* 20, 1950).

537.221 : 541.128.13 : 541.183.2

1034. Studies in contact potentials. I. The adsorption of some gases on evaporated nickel films. J. C. P. MIGNOLET. *Disc. Faraday Soc., No.* 8, 105–14 (1950).

Surface potentials have been determined for a number of gases on unoriented evaporated Ni deposits. The chemical films studied are: Ni—H : − 0·345 V; Ni—C_2H_2: + 1·0 V; Ni—C_2H_4: + 0·83 V. Contact potential appears to be suitable for directly studying surface reactions involved in the catalytic hydro-

genation of C_2H_2 and C_2H_4 on Ni. Van der Waals' films of non-polar gases may exhibit considerable surface potentials: Ni—Xe: + 0·85 V; Ni—N_2: + 0·21; Ni—C_2H_6: + 0·77 V. Surface potential appears to afford a criterion of limited applicability for distinguishing between van der Waals' adsorption and chemisorption. A.

537.221 : 541.128.13 : 541.183.2

1035. Studies in contact potentials. II. Vibrating cells for the vibrating condenser method. J. C. P. MIGNOLET. *Disc. Faraday Soc., No.* 8, 326–31 (1950).

Cells are described for measuring surface potentials of films adsorbed on evaporated metal deposits using the vibrating condenser method of Zisman. Essentially they are electrically-driven, hollow tuning forks. Sources of error are pointed out and precautions to be taken, given. The accuracy is ± 1 or 2 mV on individual contact potential measurements and ± 10 or 20 mV on surface potential determinations. A.

537.226.1

1036. The dependence on state of the apparent dipole moments of ethylamine, diethylamine and triethylamine. G. A. BARCLAY, R. J. W. LE FÈVRE AND B. M. SMYTHE. *Trans. Faraday Soc.*, **46**, 812–20 (*Oct.*, 1950).

Using the Debye–Clausius–Mosotti and other usual formulae the following moments are reported: $EtNH_2$, 1·22$_6$, 1·32, 1·09; Et_2NH, 0·920, 1·03, 1·11; Et_3N, 0·660, 0·91, 0·76 D. In each case the figures refer respectively to the gaseous, dissolved (C_6H_6), and liquid states. The new data are compared with those for NH_3 and the related methylamines. Each of the three ethylamines shows a positive solvent effect in benzene. As a class, the amines do not seem to fit equations which previously have satisfactorily connected true moments, obtained from gases, with their corresponding apparent values determined in solution. Disagreement is quantitative rather than qualitative. Possible reasons for this are mentioned. A.

537.226.1

1037. Solvent effects in dipole moment measurements. I. G. ROSS AND R. A. SACK. *Proc. Phys. Soc., Lond. B*, **63**, 893–906 (*Nov.*, 1950).

Previous theories advanced to account for the differences between the moments of polar molecules, as measured in dilute solution (in non-polar solvents) and from gas measurements, are discussed on the basis of an internal field function ξ, determining the field inside an ellipsoidal obstacle in a polarized uniform medium. Contours of ξ as a function of the axial ratios of the ellipsoid have been calculated. Onsager's theory of the static dielectric constant is extended to account for the solvent effect in ellipsoidal solute molecules of uniform polarizability, in which the dipole is parallel to one of the axes of the ellipsoid; the new equation thus obtained gives results in better agreement with experimental data than previous theoretical treatments. The rule that the sign of the solvent effect of a substance should be opposite to that of its Kerr constant is shown not to be of general applicability. A.

537.226.2

1038. On the anomalous dielectric properties of mixture of lead titanate and strontium titanate. S. NOMURA AND S. SAWADA. *J. Phys. Soc. Japan*, **5**, 279–80 (*July–Aug.*, 1950).

537.226.2

1039. Dielectric constants of cane sugar. D. A. A. S. NARAYANA RAO. Letter in *Curr. Sci.*, **19**, 276–7 (*Sept.*, 1950).

537.226.2 : 538.21

1040. On the interest of the study of magnetic powders by the use of electromagnetic waves. P. ABADIE, I. EPELBOIN AND B. PISTOULET. *C.R. Acad. Sci., Paris*, **231**, 762–4 (*Oct.* 16, 1950) *In French.*

At very high frequencies the dielectric constant and permeability of a mixture of a dielectric and a magnetic powder may, in some cases, be calculated from the proportions of the mixture and the constants of the individual constituents. A similar behaviour is found in the case of magnetic resonance in an applied field. A. E. DE BARR

537.226.2 : 548.0

1041. Domain structure of Rochelle salt. J. FURUICHI AND T. MITSUI. Letter in *Phys. Rev.*, **80**, 93–4 (*Oct.* 1, 1950).

537.226.2 : 548.7

1042. Displacement of oxygen in $BaTiO_3$. E. T. JAYNES. Letter in *Phys. Rev.*, **79**, 1008–9 (*Sept.* 15, 1950).

The ferroelectric properties of $BaTiO_3$ and the crystal symmetry in each phase are explained by motion of the O atoms in three sets, one atom per unit cell being displaced at each transition point. D. H. WHIFFEN

537.226.3

1043. Dielectric relaxation in liquids and solids. C. P. SMYTH. *Elect. Engng, N.Y.*, **69**, 975–80 (*Nov.*, 1950).

Recent experimental work, in particular microwave measurements on anomalous dispersion in liquids, is summarized and related with theory. There are 76 references. J. H. MASON

537.226.3 : 666

1044. The relation between the dielectric losses and the composition of glass. J. M. STEVELS. *J. Soc. Glass. Techn.*, **34**, *T*80–100 (*June*, 1950).

Three kinds of losses are to be expected due respectively to relaxation, deformation and vibration of the constituents of the network and the network modifiers. The dependence of each on the frequency and the temperature is discussed. These theoretical considerations are compared with a number of experimental results, and the dependence of the various kinds of losses on the composition is discussed. A.

537.226.8 : 621.319

1045. On certain matters pertaining to electrets. W. F. G. SWANN. *J. Franklin Inst.*, **250**, 219–48 (*Sept.*, 1950).

The object is to trace the mathematical consequences of the assumption that an electret consists of (1) a distribution of polarization which decays with time, (2) a distribution of surface and volume charge which disappears according to ohmic conductivity having

no relation to the decay of the polarization. The electret is supposed provided with metal plates permanently attached to its surface and to have a thickness of 1 cm and a radius of 3 cm. Starting with one plate at zero potential and the other at a negative potential V_0, symbolizing in the ordinary terminology the condition in which the electret shows a "heterocharge," the absolute value of V decays with time to zero. It then rises to a positive maximum, after which it again decays with time, ultimately to zero. The functional relation between potential difference and time is independent of the charge distribution within the electret and of its decay. The only parameters involved are the resistance R connecting the plates and the parameter determining the rate of decay of the polarization. However, while the initially produced polarization plays a part in determining the max. positive potential V_m attained and while V_0 plays a part in determining the time for the potential to change from V_0 to zero, neither of these quantities plays any part in determining the subsequent time for rise to the maximum V_m. If the resistance is such as would be determined by ordinary ohmic conductivity in a substance of the normal specific resistance of a wax, if the polarization decays according to a factor $e^{-\alpha t}$, and if α is 10^{-8} sec^{-1}, corresponding to a decay of the polarization to $1/e$ of its initial value in about 3 years, then, starting with $V_0 = -2\,000$ V and with the initially produced polarization such as to make $V_m = 2\,000$ V, there results the following: V will change from its original value $-2\,000$ V to zero in about $1\frac{1}{2}$ days, then it will rise to the positive maximum V_m in about 2 weeks, after which it will decay to $\frac{1}{3}$ of that maximum value in about three years. A.

537.228.1

1046. The variation with temperature of the piezoelectric coefficients of quartz. A. C. LYNCH. *Proc. Phys. Soc., Lond. B*, **63**, 890–2 (*Nov.*, 1950).

The equivalent electrical circuits of 3 bars in longitudinal vibration were measured at approximately 25, 52·5 and 80°C. In this range of temperature the temperature coefficients of d_{11} and d_{14} are respectively -2_{30} and $+13_{60}$ parts/million/°C, and there is no evidence to support Cady's suggestion that d_{11} passes through a maximum near room temperature. The measurements suggest a rather high value for d_{14}: $(-2{\cdot}21 \pm 0{\cdot}1) \times 10^{-8}$ cm/e.s.u. of potential at 25°C.

537.29 : 535.214.6

Combined effect of a high frequency [electric] field and an intense beam of light on particles suspended in air. *See Abstr.* 920

ELECTRIC CONDUCTION . CURRENTS 537.3

537.311.31 : 539.234

1047. Experiments at normal temperatures on the electrical conductivity of very thin silver films under intense electric fields. A. BLANC-LAPIERRE AND M. PERROT. *J. Phys. Radium*, **11**, 563–9 (*Oct.*, 1950) *In French.*

A Ag film of resistance less than 1 ohm was evaporated on to a plane glass substrate and a narr strip of width from 0·04 to 0·2 mm was remov across the centre. A further film was evaporated to the assembly in very high vacuum and by t means an extremely thin film of Ag fitted with current electrodes was obtained. Its electri properties could be measured at room temperatu *in vacuo* without removing from the system. It w found that current decreased roughly exponentia with time, for periods up to 7 hours after the depo tion; the greatest decrease occurring in the fi 10 minutes. Voltage-current curves were taken d.c. and oscillographic methods, and for appli potentials of 10 V or more, considerable departu from Ohm's law and regions of dynamic negati resistance were found. The curves thus show mark anomalies in V–I properties but little evidence rectification as evinced by asymmetric conductio The properties remain consistently constant from to 10 000 c/s. The results are not explained, therm effects being considered insufficient to provide complete explanation. C. A. HOGAR

537.311.

1048. Experiments on the measurement of t electrical conductivity of grey tin. G. BUSCH, WIELAND AND H. ZOLLER. *Helv. Phys. Acta*, (*No.* 5) 528–9 (1950) *In German.*

α–Sn is found to be a semi-conductor with activation energy ~ 0·1 eV. There is a large magnet resistance. At low temperatures traces of Al transfor α–Sn into an impurity-type semi-conductor.

R. B. DING

537.311.

1049. The electrical conductivity of molybdenu trioxide. P. STÄHELIN AND G. BUSCH. *Helv. Phy Acta*, **23** (*No.* 5) 530–1 (1950) *In German.*

Experiments on sublimated Mo O_3 show that it a reduction-type semi-conductor with the san activation energy (~ 0·5 eV at low temperatures) all directions. R. B. DING

537.311.

1050. On the anomalous electrical properties β – Cu_2S. II. T. KUSHIDA. *J. Sci. Hiroshi Univ., Ser. A*, **14**, 147–50 (*March*, 1950).

See Abstr. 6494 (1950) for part I. Specimens deficit-conducting Cu_2S, 3 × 3 × 14 mm, were prepar by direct combination of Cu and S in stoichiometr proportions and their d.c. conductivities determined b a potential probe method. Conduction is part electronic and part ionic so that polarization ar time effects modify the experimental results. It found that on increasing the current from zero, t conductivity σ decreases gradually, but that when t voltage reaches some threshold value, the Knic point, σ increases suddenly. The effect is studied a function of temperature and to some extent slight deviations from stoichiometric composition and it is shown to be a volume and not a barrie layer effect. C. A. HOGART

537.311.3

1051. Neutral impurity scattering in semiconductor C. ERGINSOY. Letter in *Phys. Rev.*, **79**, 1013–1 (*Sept.* 15, 1950).

In semi-conductors at low temperatures and fo

the case where most impurities are non-ionized, scattering of electrons by neutral impurity centres can provide an appreciable contribution to the resistance. The theoretical treatment of the problem is similar to that for the scattering of slow electrons by H atoms [Abstr. 6199 (1949)], and a more exact solution of the problem using results of Massey and Moiseiwitch [Abstr. 6546 (1950)] is suggested. C. A. HOGARTH

537.311.33

1052. On the nature of a soldered contact on a semiconductor. J. I. PANTCHECHNIKOFF. Letter in *Phys. Rev.*, **79**, 1027 (*Sept.* 15, 1950).

537.311.33

1053. Theory of the flow of electrons and holes in germanium and other semiconductors. W. VAN ROOSBROECK. *Bell Syst. Tech. J.*, **29**, 560–607 (*Oct.*, 1950).

A theoretical analysis of the flow of added current carriers in homogeneous semi-conductors is given. The simplifying assumption is made at the outset that trapping effects may be neglected, and the subsequent treatment is intended particularly for application to Ge. In a general formulation, differential equations and boundary-condition relationships in suitable reduced variables and parameters are derived from fundamental equations which take into account the phenomena of drift, diffusion, and recombination. This formulation is specialized so as to apply to the steady state of constant total current in a single cartesian distance co-ordinate, and properties of solutions which give the electrostatic field and the concentrations and flow densities of the added carriers are discussed. The ratio of hole to electron concentration at thermal equilibrium occurs as parameter. General solutions are given analytically in closed form for the intrinsic semi-conductor, for which the ratio is unity, and for some limiting cases as well. Families of numerically obtained solutions dependent on a parameter proportional to total current are given for *n*-type Ge for the ratio equal to zero. The solutions are utilized in a consideration of simple boundary-value problems concerning a single plane source in an infinite filament. A.

537.311.33

1054. On the forming processes in selenium rectifiers containing thallium. A. HOFFMANN. *Z. Phys.*, **128** (*No.* 3) 414–31 (1950) *In German.*

A method due to Lehovec is employed to determine the effect of various impurities on the performance of Se rectifiers, and involves the determination of capacity by an oscillographic method. For a counter-electrode with known Tl content there is found: (*a*) a decrease in depth of defects in the barrier layer; (*b*) an increase in forward resistance; and (*c*) an increase in barrier height. Heat treatment of the Se at 210°C, with or without Tl-containing counter electrodes, is found to affect markedly the rectification ratio. A theory of the forming based on a diffusion of impurities is offered. C. A. HOGARTH

537.311.33 : 537.311.4

1055. A study of electrical forming phenomena at selenium contacts. H. K. HENISCH AND J. EWELS. *Proc. Phys. Soc., Lond. B*, **63**, 861–76 (*Nov.*, 1950).

An account is given of current-creep experiments at various temperatures on Se specimens of different impurity content. The dependence of these phenomena on the electrical and thermal history of the specimens and on the nature of the counter-electrode is investigated. It is shown that two opposing creep mechanisms are, in general, active simultaneously. One is due to power dissipation within the barrier layer, the other due to structural changes which take place under the influence of the applied field. It was found, contrary to theoretical expectations, that creep processes cannot be "frozen out" at low temperatures (e.g. −183°C). Measurements of the self-capacitance of the barrier were carried out at suitable stages of the experiment. These show that the thickness of the barrier increases slightly during forming. A theory of current creep is proposed on the basis of the present observations. A.

537.311.33 : 541.128.13

Semi-conductivity and catalysis. *See Abstr.* 1400

537.311.33 : 541.128.13

1056. Electronic conductivity and surface equilibria of zinc oxide. D. J. M. BEVAN AND J. S. ANDERSON. *Disc. Faraday Soc.* (*No.* 8) 238–46 (1950).

The electronic conductivity of ZnO at 500–1 000°C, in air, varied widely according to the mode of preparation of the oxide. At low O pressures the conductivity is quasi-metallic, and fairly reproducible for different samples, irrespective of their origin. It is suggested that the differences between samples arise largely from the variation in relative importance of surface-conduction and bulk-phase conduction processes. For any one sample, the conductivity in O at pressures greater than 0·01–0·1 mm varies with O pressure in readily reversible fashion, according to the law $K = A \times p_{O_2}^{-\frac{1}{4}}$, as required for impurity conduction arising from the reaction $O^{2-} = \frac{1}{2}O_2 + 2e$ occurring at the surface. At low O pressures, however, the conductivity becomes independent of O pressure; equilibrium is attained under these conditions by a process which is slow, structure sensitive and attended with hysteresis. It is suggested that this involves a diffusion process, which gives rise to a heterogeneous surface at low pressures. The bulk-phase conductivity of ZnO is probably high, but electrons are trapped by chemisorption of O on the surface. It has been found that the conductivity of ferric oxide at 500–600° displays similar features, a pressure-independent conducting state preceding the dissociation to Fe_3O_4. A.

537.311.33 : 548.0

1057. Deformation potentials and mobilities in non-polar crystals. J. BARDEEN AND W. SHOCKLEY. *Phys. Rev.*, **80**, 72–80 (*Oct.* 1, 1950).

The method of effective mass, extended to apply to gradual shifts in energy bands resulting from deformations of the crystal lattice, is used to estimate the interaction between electrons of thermal energy and the acoustical modes of vibration. The mobilities of electrons and holes are thus related to the shifts of the conduction and valence-bond (filled) bands, respectively, associated with dilations of longitudinal waves. The theory is checked by comparison of the sum of the shifts of the conduction and valence-bond bands, as derived from the mobilities, with the shift of the energy gap with dilation. The latter is obtained

independently for Si, Ge and Te from one or more of the following: (1) the change in intrinsic conductivity with pressure, (2) the change in resistance of an n–p junction with pressure, and (3) the variation of intrinsic concentration with temperature and the thermal expansion coefficient. Higher mobilities of electrons and holes in Ge as compared with Si are correlated with a smaller shift of energy gap with dilation. A.

537.311.33 : 621.314.63 : 621.315.59

1058. Theory of relation between hole concentration and characteristics of germanium point contacts. J. Bardeen. *Bell Syst. Tech. J.*, **29**, 469–95 (*Oct.*, 1950).

The theory of the relation between the current/voltage characteristic of a metal-point contact to n-type Ge and the concentration of holes in the vicinity of the contact is discussed. It is supposed that the hole concentration has been changed from the value corresponding to thermal equilibrium by hole injection from a neighbouring contact (as in the transistor), by absorption of light or by application of a magnetic field (Suhl effect). The method of calculation is based on treating separately the characteristics of the barrier layer of the contact and the flow of holes in the body of the Ge. A linear relation between the l.v. conductance of the contact and the hole concentration is derived and compared with data of Pearson and Suhl. Under conditions of no current flow the contact floats at a potential which bears a simple relation, previously found empirically, with the conductance. When a large reverse voltage is applied the current flow is linearly related to the hole concentration, as has been shown empirically by Haynes. The intrinsic current multiplication factor, α, of the contact can be derived from a knowledge of this relation. A.

537.311.37

1059. The electrical conductivity of an ionized gas. R. S. Cohen, L. Spitzer, Jr., and P. Mc. R. Routly. *Phys. Rev.*, **80**, 230–8 (*Oct.* 15, 1950).

The interaction term in the Boltzmann equation for an ionized gas is expressed as the sum of two terms: a term of the usual form for close encounters and a diffusion term for distant encounters. Since distant encounters, producing small deflections, are more important than close encounters, consideration of only the diffusion term gives a reasonably good approximation in most cases and approaches exactness as the temperature increases or the density decreases. It is shown that in evaluating the coefficients in this diffusion term, the integral must be cut off at the Debye shielding distance, not at the mean interionic distance. The integro-differential equation obtained with the use of this diffusion term permits a more precise solution of the Boltzmann equation than is feasible with the Chapman–Cowling theory. While one pair of coefficients in this equation has been neglected, the remaining coefficients have all been evaluated, and the resultant equation solved numerically for the velocity distribution function in a gas of electrons and singly ionized atoms subject to a weak electrical field. Special techniques were required for this numerical integration, since solutions of the differential equation proved to be unstable in both directions. For high temperatures and low densities the computed electrical conductivity is about 60% of the value given by Cowling's second approximation. A

537.312.

1060. Studies on the relations between the spectral sensitivity of selenium photoelements and the photoelectric current and load resistance. I. Wolf. *Ann. Phys. Lpz.*, **8** (*No.* 1–2) 30–40 (1950) *In German.*

The presumed proportion between the photoelectric current and the incident light intensity does not exist. The spectral sensitivity varies with the photoelectric current. If the photocurrent is proportional to the intensity, a line parallel to the abscissa will result. This is the ideal case. In fact the lines deviate more or less. This deviation increases with increasing intensity and load resistance. The ratio of the photocurrents increases at a slower rate than the ratio of the intensities. This discrepancy becomes the more marked the greater the load resistances are. The deviation of the curves from the straight line (ideal case) is a measure of the non-proportionality. The reason for this behaviour is found in the fact that the ratio photocurrent/incident intensity is non-proportional for the various wavelengths. W. SUMMER

537.312.

1061. Changes in the activation energy of tellurium. T. S. Moss. Letter in *Phys. Rev.*, **79**, 1011–12 (*Sept.* 15, 1950).

The resistance of Te changes towards lower values by a factor of several hundreds when increasing pressure is applied to the Te. The threshold wavelength of sensitivity moves into the infrared region as the temperature of the Te cell is reduced. It is concluded that the threshold of a Te cell under 20 000 kg/cm² pressure would be located in the infrared at 12 μ. W. SUMMER

537.312.5 : 537.311.3

1062. The properties and mechanism of the photoelectric emission of Cs–Sb layers. W. Veith. *J. Phys. Radium*, **11**, 507–13 (*Aug.–Sept.*, 1950) *In French.*

The Cs–Sb layers must be considered semiconductors, not alloys. It is suggested that the highly sensitive layers Cs_2O, Ag, Cs, are not metallic but semiconductors. In the case of the Cs_3Sb layer it is shown that each sensitivity max. occurs at a conductivity min. The resistance of these layers is sufficiently high to account for errors, if neglected. This is important in the case of photoelectronic telescopes. A surplus of Cs is necessary in the formation of this type layer. The addition of O_2 is favourable if Cs is in excess, but is unfavourable when the max. sensitivity has been passed. The addition of O_2 reduces the sensitivity if Cs is lacking. The addition of O_2 extends the spectral sensitivity into the red (a little O_2) and infrared (much O_2). W. SUMMER

537.312.6 : 536.531 : 621.3.011.2 : 621.316.8

1063. A relationship between resistance and temperature of thermistors. G. Bosson, F. Gutman and L. M. Simmons. *J. Appl. Phys.*, **21**, 1267– (*Dec.*, 1950).

The equation $\log R = A + B/(T + \theta)$ for the resistance R of a thermistor at T°K is proposed

Least square analyses of the most precise resistance-temperature data available for 3 different thermistor materials show that the equation is a considerable improvement over its predecessors; the standard relative errors of fit are 0·4, 0·17 and 0·91%. A.

537.312.62

1064. Superconductivity and Debye modes. W. BAND. Letter in *Phys. Rev.*, **79**, 1005 (*Sept.* 15, 1950).

If the temperature of the coherence-incoherence transition of phase domains of Debye modes [see Abstr. 321 (1951)] is identified with the transition temperature T_c of a superconductor, a reasonable order of magnitude is obtained for T_c; the observed variation of T_c with the square root of isotopic mass is also obtained. D. SHOENBERG

537.312.62

1065. Superconductivity of columbium nitride. D. B. COOK, M. W. ZEMANSKY AND H. A. BOORSE. Letter in *Phys. Rev.*, **79**, 1021 (*Sept.* 15, 1950).

537.321 : 537.312.62

1066. The thermoelectromotive force of tin at the superconducting-normal junction. R. T. WEBBER AND M. C. STEELE. Letter in *Phys. Rev.*, **79**, 1028–9 (*Sept.* 15, 1950).

537.363

1067. The cataphoresis of spherical particles in strong fields. F. BOOTH. *J. Chem. Phys.*, **18**, 1361–4 (*Oct.*, 1950).

The problem of determining the rate of cataphoresis of a solid spherical particle in an electrolyte when relaxation effects are neglected, is solved completely by using Oseen's equations. The bearing of the results on the usual methods of finding zeta-potentials from cataphoretic velocities is discussed. A.

537.363

1068. On a procedure to measure the charges carried by fine electrified particles. L. GODARD AND C. LAFARGUE. *C.R. Acad. Sci., Paris*, **231**, 786–7 (*Oct.* 16, 1950) *In French.*

The fine particles (raindrops, fog, snow crystals and aerosols) are trapped in a fluid of known viscosity (usually a silicone) between the plates of a parallel plate condenser. Their movement under a known potential difference is observed with a microscope and the charge calculated by the application of Stokes's law. J. M. HOUGH

ELECTRIC DISCHARGES 537.52

537.521.7 : 621.3.015.5

1069. Notes on the pre-discharge displacement current in long spark gaps. E. S. KUKHARKIN. *Elektrichestvo, No.* 10, 35–7 (*Oct.*, 1950) *In Russian.*

Certain discrepancies between the results of an approximate calculation and experimental data are pointed out. The approximation is based on the assumption that the current of the leader channel is equal to the displacement current issuing from the hemispherical head of the channel. This leads to a fairly simple calculation based on electromagnetic theory, but the discrepancies with experiment raised doubts whether it is correct to identify the radius of the conducting head of the leader with the radius of the luminous channel, and the potential of the head with the initial discharge potential. These two premises seemed to conflict in themselves, considering the assumed values (0·1 cm for radius and 30 kV/cm for the gradient) and the improbability of a considerable voltage drop over the leader channel. A further uncertainty arose from the unfounded assumptions regarding ionic density in the channel; implying that nearly up to inception of discharge the head of the leader is almost at electrode potential. The potential gradient must thus be of a higher order than that assumed. Such gradients produce displacement currents of the observed order of magnitude. The assumption of a much greater effective radius of the head of the leader further reduces the margin between theory and experiment. B. F. KRAUS (R)

537.523 : 545.82

1070. A concentration-dependent H–D exchange process at the surface of aluminium cathodes. E. KÜHNE-SAUTER. *Z. Naturforsch.*, **5a**, 499–501 (*Sept.*, 1950) *In German.*

When an Al cathode is used in a glow discharge with D_2O–H_2O mixtures, spectrographic analysis shows that the surface composition depends on the concentration of the mixture. When the D_2O concentration is larger than $Deq/Heq = 1/400$ the deuterium in the cathode increases, while for small concentrations it diminishes. A. H. W. BECK

537.523.5

1071. A microwave study of the high pressure arc. J. D. COBINE, E. P. CLEARY AND W. C. GRAY. *J. Appl. Phys.*, **21**, 1264–7 (*Dec.*, 1950).

The impedance of an atmospheric-pressure d.c. arc was measured at 1 000 mc/sec by means of a coaxial line and standing wave detector. The reactance and resistance of the arc, an essentially lumped load at the end of the line, increase with length of arc. The resistance decreases with increasing current and is approximately the same as the d.c. "resistance." The reactance is capacitive and nearly independent of current. Air, A and He were studied at currents from 1–4 amp d.c. arc current. A.

537.523.5

1072. High temperature plasma properties from high current arc stream measurements. W. FINKELNBURG AND S. M. SEGAL. *Phys. Rev.*, **80**, 258–60 (*Oct.* 15, 1950).

The high-current arc stream in air, operated at currents between 150 and 250 amperes, with an axial temperature between 10 000 and 12 000°K, is shown to be a very uniform high temperature plasma. Probe measurements of the potential gradient along the axis of the arc stream, and of its effective diameter, lead to the conclusion that its plasma has a constant electrical resistivity of 1/100 ohm/cm, widely independent of the arc current. From this resistivity, the current density, the potential gradient and the plasma temperature, empirical values of the electron mobility, their relaxation length, and the effective ion cross-sections in the plasma are derived. The value of the ion cross-section agrees well with that computed from

a theoretical formula of Druyvesteyn, but is by a factor smaller than those generally considered correct. A.

537.525

1073. Techniques for measuring the dynamic characteristics of a low pressure discharge. B. T. Barnes and S. Eros. *J. Appl. Phys.*, **21**, 1275–8 (*Dec.*, 1950).

These can be determined by making square-wave changes of arc current. This is done by putting the discharge tube in the plate circuit of a group of pentodes connected in parallel and supplied with a square-wave signal superimposed on a d.c. bias. Probes operated at constant current are useful for a modulated discharge. For measuring electron temperature, two identical probes are centered about points having the same space potential and operated at different fixed currents on the straight line part of the probe characteristic. For longitudinal voltage gradient or radial potential differences identical probes operated at the same current are used. A probe operated at a suitable current will follow roughly the variations in space potential of the adjacent region of the discharge. Another probe made sufficiently negative with respect to such a probe will collect only positive ions. A probe made 0–10 volts positive with respect to the constant-current one gives records from which electron concentrations can be computed. The oscillograph amplifier for dynamic probe records must be either differential or with ungrounded power supply. In the latter case, the stray capacitance is many times larger; but fairly reliable records can be obtained if the arc current is 0·1 amp or more, and if the time constant for the decay of the transient effects being measured is at least 10 μsec. The oscilloscope amplifier and any preamplifier used for recording spectral intensities should be direct-coupled. A.

537.525 : 537.523 : 621.3.015.5

1074. Microwave gas discharges. M. A. Biondi. *Elect. Engng, N.Y.*, **69**, 806–9 (*Sept.*, 1950).

A review of the basic physics of microwave gaseous discharges, discussing the complex conductivity of a discharge, the u.h.f. breakdown mechanism and the general physical properties of microwave discharges. J. D. CRAGGS

537.525 : 538.69

1075. The effect of magnetic field on the breakdown of gases at microwave frequencies. B. Lax, W. P. Allis and S. C. Brown. *J. Appl. Phys.*, **21**, 1297–304 (*Dec.*, 1950).

The presence of energy resonance and the modification of diffusion are shown experimentally and explained theoretically. An application is made of both the average electron theory and the Boltzmann theory, and the correspondence between these two theories is discussed. A.

537.525.3

1076. "Joshi effect" in iodine vapour under X-rays. A. P. Saxena and P. K. Karmalkar. Letter in *Curr. Sci.*, **19**, 275–6 (*Sept.*, 1950).

Describes results obtained with the irradiation of I vapour, in a Siemens ozonizer tube, by means of X-rays and white light. The experimental data are then briefly discussed in relation to various theories of the Joshi effect. J. D. CRAGGS

537.525.5

1077. Experiments on the initiation of electric arcs. F. E. Haworth. *Phys. Rev.*, **80**, 223–6 (*Oct.* 15, 1950).

Arcs have been struck in vacuum between widely spaced electrodes by positive ion charging of an insulating film on the cathode, at separations from 0·5 to 5 mm and at potentials from 34 to 2 000 V. The arc current must be allowed to grow initially at the rate of at least 10^6 amp/sec for the arc to occur. These experiments constitute a test of one of the fundamental steps postulated to account for the initiation of an arc between electrodes coming together at low voltages. A.

537.525.6

1078. A floating double probe method for measurements in gas discharges. E. O. Johnson and L. Malter. *Phys. Rev.*, **80**, 58–68 (*Oct.* 1, 1950).

Measurements with a Langmuir probe in varying or decaying plasmas are defeated by the fact that the plasma potential in these cases follows that of the most positive electrode it can contact. The difficulties can be obviated by the use of a pair of probes joined by a variable potential source. The double probe system "floats" with respect to the discharge system. From the measurements of probe current *v.* differential probe voltage, electron temperature and plasma densities can be determined. The method is also applicable to "going" discharges where it has the advantage over the single probe of exerting a negligible influence on the discharge. A.

537.525.6

1079. Production of 2537 radiation and the role of metastable atoms in an argon–mercury discharge. C. Kenty. *J. Appl. Phys.*, **21**, 1309–18 (*Dec.*, 1950).

The average population of 6^3P_1 Hg atoms is calculated from the measured 2537 output and resonance radiation diffusion theory. Average populations of $6^3P_{2,0}$ are then found by comparing the absorptions of 5461, 4358 and 4047. Populations for a 0·42-amp discharge in 3·5-mm A of high purity plus Hg vapour at 42°C in a tube 1½ in diam. are for $6^3P_{2,1,0}$, respectively, $7{\cdot}6\times10^{11}$, $1{\cdot}9\times10^{11}$ and $3{\cdot}5\times10^{11}$ cm^{-3}; these are ½, 1/20 and ⅛ of the corresponding Boltzmann populations, for the electron temperature of 11 100°K. Rates of collisions of the first and second kinds involving electrons (average concentration $2{\cdot}1\times10^{11}$ cm^{-3}) and the 6^1S_0 and $6^3P_{2,1,0}$ states are calculated using known excitation functions and detailed balancing. The results predict populations for $6^3P_{2,1,0}$ within 10% of those observed; they further predict that ⅔ of the observed 2537, ¾ of the visible triplet, and ¾ of the 3650 group are produced stepwise via 6^3P. Quenching collisions involving A are assumed negligible. The results account fairly well for the maximum in the 2537 *v.* Hg pressure curve, for the decrease in the 2537 output efficiency with increasing current, and for the decrease in electron temperature which is associated with both these effects. A.

537.525.8

1080. A new form of discharge in gas mixtures: the flashing discharge. C. KENTY. Letter in *Phys. Rev.*, **80**, 96 (*Oct.* 1, 1950).

The condition is described and the resulting phenomenon discussed when a sudden discharge is produced in mixtures of Hg vapours and such gases as will ionize the Hg. In between flashes, the tube remains dark. These are the visual signs of two different physical states that are not co-existent. In the dark period the energy goes into the Hg resonance radiation while in the flash it goes into the Hg that is ionized by A′. Other gases, e.g. Xe′, cannot ionize Hg. Kr′ has the same effect as A′. W. SUMMER

537.525.83

1081. Role of metastable ($^3P_2$) Hg atoms in low current discharges in Hg rare gas mixtures. C. KENTY. Letter in *Phys. Rev.*, **80**, 95–6 (*Oct.* 1, 1950).

537.527.3 : 537.527.4

1082. Positive point-to-plane spark breakdown of compressed gases. T. R. FOORD. Letter in *Nature, Lond.*, **166**, 688–9 (*Oct.* 21, 1950).

Breakdown voltage/pressure curves for carefully purified N_2 show that the spark breakdown and corona onset curves practically coincide whereas, as had been previously shown, electron-attaching gases such as SF_6 and CCl_2F_2 show that for lower pressures the sparking voltage curve lies above the corona onset curve but coincides with it at higher pressures. These effects are now tentatively explained in terms of attachment processes which, when operative, tend to retard the growth, from a Townsend avalanche, of a streamer. Normally, it is suggested, the streamer, once formed, will cross the gap, at high pressures, with the voltage raised only slightly above the onset value. Reasons for this are given. J. D. CRAGGS

537.527.4 : 621.3.015.5

1083. Influence of electrodes on D-C breakdown in gases at high pressure. J. G. TRUMP, R. W. CLOUD, J. G. MANN AND E. P. HANSON. *Elect. Engng, N.Y.*, **69**, 961–4 (*Nov.*, 1950).

D.c. breakdown measurements up to 900 kV between metallic electrodes producing a uniform field and immersed in compressed gases show markedly higher values for stainless steel after conditioning by sparkover than for Al electrode systems. Sparkover voltage measurements were made in air, in CO_2, in equal mixtures of CO_2 and N, and in N. The relative insulating strength of these gases diminished in the order listed, and a similar electrode dependence on higher pressure was shown in all of them. A.

X-RAYS 537.531

537.531 : 53.081.6

1084. A precision evaluation of *h/e* by X-rays. J. A. BEARDEN AND G. SCHWARZ. *Phys. Rev.*, **79**, 674–84 (*Aug.* 15, 1950).

Precision X-ray measurements of *h/e* have been made at potentials from 8 000 to 19 000 V. A double crystal spectrometer with perfect calcite crystals was used as the monochromator. The window width was 0·7 V. A unipotential cathode was developed and the use of this with the narrow monochromator window gave isochromats which broke very sharply at the high frequency limit. Isochromats were recorded with both W and oxide cathodes which experimentally indicated the necessity for making the work function correction to the applied voltage. No evidence was found to support the previously reported effects due to surface films on the target or gas pressure in the X-ray tube. Targets of Au, W, Ta, Mo, Ni and Cu were used. The pronounced structure near the high frequency limit appears to be much the same for all targets, differing only in some details and magnitude. The value found for *h/e* is $1{\cdot}37938 \pm 0{\cdot}00008 \times 10^{-17}$ erg sec e.s.u.$^{-1}$ and is independent of the target or voltage used. [See also Abstr. 1138 (1951)]. A.

537.531 : 535.33

1085. Observations on the *K*-emission discontinuities of Al and Mg in dilute alloys. Y. CAUCHOIS. *C.R. Acad. Sci., Paris*, **231**, 574–6 (*Sept.* 18, 1950) *In French.*

Observations on Cu_9Al and on alloys containing from 1·5% to 10·2% Mg indicate that in all cases the characteristic *K* discontinuity appears in the same position. No discontinuity was observed in an alloy with 0·95% Mg. A. E. DE BARR

537.531 : 535.34

1086. The determination of X-ray wavelength distributions from absorption data. J. R. GREENING. *Proc. Phys. Soc. Lond. A*, **63**, 1227–34 (*Nov.*, 1950).

An existing empirical method which may be used, in limited cases, to determine X-ray wavelength distributions from absorption data is given some theoretical foundation. It is shown that the absorption curve function and the wavelength distribution function have the same relationship as a Laplace pair, the absorption curve function being the Laplace transform of the wavelength distribution function. The theory leads to the suggestion of Laplace pairs other than the one previously suggested, thus widening the scope of the method. By using the additive property of Laplace transforms the absorption method of determining spectral distributions is made of general application. The experimental requirements are discussed and examples of wavelength distributions determined by the absorption method are given. A.

537.531 : 535.43

1087. The present state of the theory of low-angle scattering of X-rays. G. FOURNET AND A. GUINIER. *J. Phys. Radium*, **11**, 516–20 (*Aug.–Sept.*, 1950) *In French.*

Treats both dilute and concentrated systems of similar particles and heterogeneous particles. A new result is given for scattering by a concentrated system of similar particles, in terms of interparticle potential and temperature. A general discussion is given of scattering in the most general case of any variation of electron density whatever. See *Ann. Phys.*, **12**, 161–237 (*Sept.*, 1939) Abstr. 1877 (1947), 1932, 2138, 2539, 7045, 7051 (1949). A. R. STOKES

537.531 : 535.434 : 541.18.02

1088. Low angle scattering of X-rays by some mineral colloids. H. Brusset and T. Kikindai. *C.R. Acad. Sci., Paris*, **231**, 858–60 (*Oct.* 23, 1950) *In French.*

Scattering curves were obtained for finely-divided ZnO, $Zn(OH)_2$, CuS, Se, MgO and Ag. Particle sizes could be derived in some cases. A. R. STOKES

537.531 : 537.533.72 : 614.8

1089. X-radiation from electron microscopes. J. H. L. Watson and L. E. Preuss. *Science*, **112**, 407–9 (*Oct.* 6, 1950).

Stray radiation measurements show tolerance dose exceeded near viewing window, but danger in normal working is small. Intermediate screen is greatest source of X-rays. F. T. FARMER

537.531 : 615.849 : 621.386.8

1090. Million-volt beryllium-window X-ray equipment for biophysical and biochemical research. W. T. Ham, Jr., and E. D. Trout. *Radiology*, **55**, 257–70 (*Aug.*, 1950).

The 180-cycle resonant transformer generator gives 1 000 kVp at 0·1–3·0 mA. The Be window of the X-ray tube is 2·5 cm in diameter and 2 mm thick, transmitting X-rays of very long wavelengths. Measurement is complicated by the wide spectral distribution. Victoreen ionization chambers of bakelite, 0·025 in, and nylon, 0·005 in wall, are used. Curves showing spatial distribution of the unfiltered beam, absorption in Pb, and depth doses in masonite for a 30 cm field, are given for 150 cm focal distance. Agreement amongst ionization chambers, good at 150 cm, becomes increasingly poor at nearer focal distances, but can be restored by introducing a magnetic field, indicating that corpuscular absorption in the bakelite chamber walls, rather than a preponderance of soft X-rays in the beam, causes the discrepancy. Estimations of dosage rate at the Be window, using the inverse square law from various focal distances, give widely differing results. Weight is given to a figure 188 000 r/min of hard X-rays. Direct determination is attempted, measuring energy absorbed in water by a constant flow method. Preliminary work indicates promise, with refinement, as a method for determining these high dosage rates. A possible total (primary plus scatter from collimator) of 5 000 000 r/min is quoted. D. V. MABBS

537.531 : 621.386.1 : 621.316.721.078

1091. A circuit for the automatic stabilization of X-ray tube current. C. S. Lees and M. D. Armitage. *J. Sci. Instrum.*, **27**, 300–1 (*Nov.*, 1950).

The electron emission of the filament in a continuously evacuated X-ray tube may change considerably over a long exposure, and the circuit described automatically maintains it constant. The 50 c/s current in the 230 V primary of the X-ray tube filament transformer is passed through a diode which carries the negative half-cycle, and a thyratron which carries the positive half-cycle. A resistor inserted in the h.t. circuit develops a voltage proportional to the X-ray tube current, and this is applied to the grid of the thyratron, so that increased X-ray tube current causes the thyratron to fire later in the half-cycle thus reducing the filament current. Adequate sensitivity is obtained with no amplification Late firing of the thyratron introduces a d.c. component and some saturation of the transformer core. The same basic circuit is also suitable for ionization gauge control. A.

537.531 : 621.396.611.4 : 621.386.1.027.89

1092. A million-volt resonant cavity X-ray tube. B. Y. Mills. *Proc. Instn Elect. Engrs, Pt III*, **97**, 425–37 (*Nov.*, 1950) [*Reprint No.* 924].

For abstract see Abstr. 5030 (1950).

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533 : 621.384.6

1093. The design of electron synchrotrons. F. K. Goward, J. D. Lawson, J. J. Wilkins and R. Carruthers. *Proc. Instn Elect. Engrs, Pt I*, **97**, 320–34 (*Nov.*, 1950) [*Reprint No.* 970].

For abstract see Abstr. 6531

537.533 : 621.384.6

1094. The design and operation of a 30-MeV synchrotron. D. W. Fry, J. Dain, H. H. H. Watson and H. E. Payne. *Proc. Instn Elect. Engrs, Pt I*, **97**, 305–19 (*Nov.*, 1950) [*Reprint No.* 971].

For abstract see Abstr. 6532 (1950).

537.533.7

1095. Cascade showers in lead. K. M. Crowe and E. Hayward. *Phys. Rev.*, **80**, 40–2 (*Oct.* 1, 1950).

A study has been made of the energy and angular distributions of the electrons produced when the X-ray beam from the 322-MeV Berkeley synchrotron falls on a slab of Pb $\frac{1}{2}$ in in thickness. A cloud chamber containing the piece of Pb was in a magnetic field of 1 800 gauss. Measurements were made on 1 286 electron secondaries having energies greater than 3 MeV. The energy and angular distributions of these electrons are in satisfactory agreement with the theory. A.

537.533.71 : 548.74

1096. On the anomalies of the small angle reflection of cathode rays from the surface of a single crystal. III. The effect of absorption. K. Kohra. *J. Phys. Soc. Japan*, **5**, 272–7 (*July–Aug.*, 1950).

See Abstr. 5033–4 (1950). The effect of absorption on the electron diffraction is studied by introducing the imaginary potential into the Schrödinger equation. The interpretation of anomalies in the lower order reflections carried out in Part 2 [Abstr. 5034 (1950)] is made more complete by considering the absorption. Finally, the several problems as to the lower order reflections are discussed. A.

537.533.72

1097. Note on the focusing of electron beams in certain magnetic fields. P. A. Sturrock. *Proc. Phys. Soc., Lond. B*, **63**, 954–7 (*Nov.*, 1950).

Equations are set out which determine the focusing properties of electron beams in magnetic fields whose scalar potential has a plane of antisymmetry. From these is derived the condition that a proposed ray-axis and associated focusing requirements should be physically realizable. It is also shown that the fringe-

effect of fields with sharply defined boundaries may be characterized by a pair of focal lengths for which formulae are given. A.

537.533.72

1098. The caustic surface of electron lenses. W. Glaser and H. Grümm. *Optik*, **7** (*No.* 2), 96–120 (1950) *In German.*

The properties of the caustic surface of an electrostatic and a magnetic lens are investigated mathematically. There is general similarity to the light optical case, especially for the electrostatic lens, the magnetic lens however giving rise to different symmetry characteristics and disposition of the surface. The results, which were deduced for a system including a diaphragm may be extended to apply to a system without a diaphragm. The general relations are numerically evaluated for a typical case, and illustrated by photographs of a scale model.

M. R. HOPKINS

537.533.72

1099. Researches and developments on the spiral orbit spectrometer. I. M. Sakai. *J. Phys. Soc. Japan*, **5**, 178–84 (*May–June*, 1950).

Theoretical and experimental investigations carried out on a type of β-ray spectrometer devised by G. Miyamoto. In this instrument electrons emerge radially from the central axis of the magnetic field between two polepieces, the field being axially symmetrical and decreasing in the outward direction. The electrons describe spiral orbits which converge on a circle when the ratio between the field and momentum is correct. Experiments were made with a hot-filament source surrounded by a cylindrical accelerating grid, giving an accelerating potential of 400–1 200 V. The electrons were collected in a Faraday cage which could be moved radially. The collection efficiency and resolution were investigated in this manner. In the theoretical investigation the effect of eccentricity of source and grid are examined, dependence of cage current on position of cage and axial focusing of particles emitted off the median plane are studied. L. R. SHEPHERD

537.533.72

1100. Researches and developments on the spiral orbit spectrometer. II. M. Sakai. *J. Phys. Soc. Japan*, **5**, 184–7 (*May–June*, 1950).

See previous Abstr. The influence of the magnetic field configuration on collecting efficiency and resolving power of the spectrometer is discussed and the modification of the polepieces to give optimum conditions is described. The field should vary as near to $1/r$ as possible at the position of the converging circle.

L. R. SHEPHERD

537.533.72

1101. Rendering visible single atoms and molecules in the field electron microscope. E. W. Müller. *Z. Naturforsch.*, **5a**, 473–9 (*Sept.*, 1950) *In German.*

Describes the field electron microscope, in which the electrons emitted from a fine W point of about 10^{-5} cm radius, which is the cathode of a vacuum tube, form an image of the point on a fluorescent screen. A ring-anode is employed and the distance from cathode to screen is about 10 cm, a magnification of 10^{-5}–10^{-6} being obtained. Theoretical and experimental reasons are given to support the claim that the images seen under various experimental conditions are those of single atoms or molecules respectively. A resolution of as little as 5Å is attained.

J. THEWLIS

537.533.72 : 621.385.833

1102. An experimental study of the illuminating system of the electron microscope. M. L. De. *Indian J. Phys.*, **24**, 303–8 (*July*, 1950).

An experimental study to determine the most efficient operating condition. The variation of the size of the electron cross-over with different grid-filament distances has been observed. An attempt has been made to correlate these observations with the final image quality. A.

537.533.72 : 621.385.833

1103. Calculation of the optical constants of magnetic electron lenses with a generalized bell shaped field. F. Lenz. *Z. angew. Phys.*, **2**, 337–40 (*Aug.*, 1950) *In German.*

The experimentally determined axial field is approximated by $H(z) = H_0\{1 + (z/a)^2\}^{-\mu}$ by fitting the maximum, half the maximum and the integral $\int_{-\infty}^{+\infty} Hdz$. The optical constants are tabulated for $\mu = 1$, 2, ∞, and $k = 0$, 3, 1·0, 1·5, 2, 3 ($k^2 = eB^2d^2/8mV$, d = width at half maximum field). The constants given are the focal lengths, focal distance, magnification, chromatic and spherical aberration constants. For earlier work see Glaser [*Z. Phys.*, **117**, 285 (1941); *Ann. Phys.*, **7**, 213 (1950)].

A. H. W. BECK (R)

537.533.73 : 548.74

1104. A standard substance for precise electron diffraction measurements. F. W. C. Boswell. Letter in *Phys. Rev.*, **80**, 91–2 (*Oct.* 1, 1950).

537.533.74

1105. The single scattering of fast electrons at small angles. G. Schulze-Pillot and W. Bothe. *Z. Naturforsch.*, **5a**, 440–7 (*Aug.*, 1950) *In German.*

The single scattering of electrons of 1–2·5 MeV is investigated for angles of 13°–25°, for polystyrene, Al, Ni, Ag and Au. A Rn source is used and the electrons are monochromatized by a magnetic lens. The results agree within 10% with those predicted by Mott's theory. J. THEWLIS

537.533.74

1106. On the scattering theory of the Dirac equation. G. Parzen. *Phys. Rev.*, **80**, 261–8 (*Oct.* 15, 1950).

It is shown that for sufficiently strong potentials, the Born approximation is not valid even at very high energies. A variational principle is derived for the phase shifts and applied to a simple case. Two exact expressions for the phase shifts are also found. A.

537.533.74

1107. The probable energy loss of electrons in matter. S. D. Warshaw and J. J. L. Chen. Letter in *Phys. Rev.*, **80**, 97–8 (*Oct.* 1, 1950).

537.533.74 : 548.0

1108. Scattering of electrons in crystals in the presence of large electric fields. J. Bardeen and W. Shockley. *Phys. Rev.*, **80**, 69–71 (*Oct.* 1, 1950).

By the calculation of transitions between states

appropriate to electrons moving in a large uniform electric field superimposed on a periodic crystal field, it is shown the probabilities of scattering by lattice vibrations or imperfections are independent of the uniform field and are given by the usual expressions derived for zero field. This justifies the procedure of treating acceleration by the field and scattering as independent processes. A.

537.533.8

1109. The "pendulum multiplication" of secondary electrons in h.f. fields. K. Krebs. *Z. angew. Phys.*, **2**, 400–11 (*Oct.*, 1950) *In German.*

The effects of multiple transits in the coaxial-line Heil tubes is investigated theoretically and practically. Earlier treatments in which the initial velocity of the secondaries is put equal to zero are extended to the case of finite emission velocities and it is shown that this can considerably extend the region in which "pendulum" effects take place. The calculations giving the critical range of h.f. amplitude agree well with the measurements. Methods of eliminating the effect are discussed. A. H. W. BECK

537.533.9

1110. Sheath formation in ion-neutralized electron beams. E. G. Linder. Letter in *Phys. Rev.*, **80**, 99–100 (*Oct.* 1, 1950).

537.534

1111. Construction of a new combined vacuum furnace and mass spectrometer for universal use. B. N. Srivastava and V. N. Saharia. *Proc. Nat. Inst. Sci. India*, **16**, 263–70 (*July–Aug.*, 1950).

A 60 degree focusing mass spectrometer is described. The ion source consists of a graphite furnace and accelerator slit, so that the ionic dissociation products of heated substances can be investigated.

T. G. PICKAVANCE

537.534

1112. Study with the electrolytic tank of ion sources used in mass spectrometry. Determination of trajectories. R. Moch, E. Roth and J. Salmon. *J. Phys. Radium*, **11**, 524–8 (*Aug.–Sept.*, 1950) *In French.*

The optics of two Nier type ion sources are studied by means of the automatic equipotential tracer of the Collège de France, and the model of a third source, based on the results obtained, is discussed.

J. THEWLIS

537.534

1113. Ion optics of the ion source of mass spectrometers. R. Vauthier. *C.R. Acad. Sci., Paris*, **231**, 764–5 (*Oct.* 16, 1950) *In French.*

The trajectories of the ions are calculated by considering the slit system of the ion source as a system of cylindrical lenses. J. THEWLIS

537.534

1114. Transverse convergence created by the slits of ion optical instruments. F. Bertein. *C.R. Acad. Sci., Paris*, **231**, 766–7 (*Oct.* 16, 1950) *In French.*

An expression is derived for the transverse convergence arising from the limited dimensions of the slits in such instruments as mass spectrometers.

J. THEWLIS

537.534 : 539.163.2

1115. A magnetic analyzer for charged-particles from nuclear reactions. C. W. Snyder, S. Rubin, W. A. Fowler and C. C. Lauritsen. *Rev. Sci. Instrum.*, **21**, 852–66 (*Oct.*, 1950).

A double-focusing magnetic spectrometer for detecting and analysing charged particles from nuclear reactions is described. The magnetic field, varying as $r^{-\frac{1}{2}}$ near an average radius of 10·5 in, extends over a semicircle yielding object and anastigmatic image positions some distance outside of the region of strong field. The acceptance solid angle is $\Omega = 0{\cdot}0061$ sterad and the momentum resolution with an 8 mm slit at the detector is $R = 128$. The ultimate resolution determined by spherical aberration and some residual astigmatism is about 1 000. Applications to the study of the energy and yield of nuclear reaction products are discussed. A.

537.534 : 621.314.634 : 621.384.62 : 621.319.52

1116. A 500-kilovolt linear accelerator using selenium rectifiers. W. R. Arnold. *Rev. Sci. Instrum.* **21**, 796–9 (*Sept.*, 1950).

A 500 kV generator for use on a linear accelerator is described. This voltage is obtained by using Se rectifiers and 1 μF condensers in 22 stages of voltage doublers. The maximum input is 9 kV r.m.s. at 750 c/s, and the max. peak inverse voltage across each rectifier and each condenser is 25 kV. The measured regulation is 25 kV/mA, the measured ripple (peak to peak voltage) is less than 1 200 V/mA; both independent of output voltage. The maximum load is 2·5 mA. A.

537.534 : 621.384.6

1117. Beam oscillations in an F-M cyclotron. T. Teichmann. *J. Appl. Phys.*, **21**, 1251–7 (*Dec.*, 1950).

Considers the radial and vertical oscillations of a synchro-cyclotron beam. It is found that various oscillations of substantially constant or increasing amplitude may occur in certain regions of the field, in which there are angular or other asymmetries, though only one possible oscillation (that at $n \simeq \frac{1}{2}$) can occur in a field that is cylindrically and vertically symmetric. The conditions for the various oscillations, and their behaviour, are discussed. A.

537.534.74

1118. Scattering of protons by carbon. W. D. Whitehead. Letter in *Phys. Rev.*, **79**, 1022–3 (*Sept.* 15, 1950).

DISCHARGE TUBES . COUNTERS 537.54

537.542

1119. Photo-adsorption by a thin film of barium. C. Biguenet. *Vide*, **5**, 831–6 (*July–Sept.*, 1950) *In French.*

In experiments on the retarding field characteristic of diodes it was found that light had a disturbing effect on the measurements. The nature of the disturbance was investigated and found to be due to variations in the surface potential of the anode, resulting in a variation of the effective c.p.d. The author investigates the hypothesis that these variations are due to photo-ionization of Ba film adsorbed on

the anode. The energetics of the process are discussed and the experimental techniques described.

A. H. W. BECK

537.542

1120. On the temperature dependence of counter characteristics in self-quenching G-M counters. OM PARKASH. Letter in *Curr. Sci.*, **19**, 273–5 (*Sept.*, 1950).

537.542

1121. The propagation of the discharge in a G.M. counter with external electrode. M. SCHÉRER AND E. VIEILLE. *C.R. Acad. Sci., Paris*, **231**, 964–6 (*Nov.* 6, 1950) *In French.*

It has been shown that the photons in a G.M. counter are not completely absorbed in the organic vapour. The existence of a photoelectric effect has been assumed, because a glass filter greatly reduced that effect. Similar investigations with a counter of the Maze type (G.M. counter with external graphite cathode) have shown that the glass envelope does not act as an obturating medium. A photoelectric effect is produced of at least the same magnitude as that of a brass cathode. W. SUMMER

537.542 : 537.531.08

1122. Long beaded counters for X-ray measurements. I. NONAKA AND Z. SHIMAZU. *J. Phys. Soc. Japan*, **5**, 283–4 (*July–Aug.*, 1950).

537.542 : 621.318.572 : 621.387.4

1123. Nuclear particle and radiation detectors. I. Ion chambers and ion-chamber instruments. D. TAYLOR AND J. SHARPE. *Instn Elect. Engrs, Paper* 1077, 17 *pp.* [*Early Proof Issue*].

A review of the operating mechanisms, special properties and constructional details of the particle and radiation detectors used in modern nuclear instruments. The detectors described are mostly those in use at the Atomic Energy Research Establishment, at Harwell. Emphasis is on the detectors themselves, but brief details are given of their use in complete instruments. The characteristics of the nuclear particles (α-particles, β-particles, protons, neutrons, fission fragments, etc.) and quanta (X-rays and γ-rays) to be detected are discussed, and classification of detectors is given, the principle of detection being explained in each case and attention being called to the two different methods of use, namely as counters responding to each individual ionizing event, and as integrating elements measuring the total energy dissipation over a given interval of time. A detailed description is given of the ion chamber, the theory of its operation and the practical details of its construction. Examples of its use in radiation monitoring apparatus and in assay instruments are given. Attention is called to the use of ion chambers in process-control instrumentation and in pile-control plants. A.

537.542 : 621.318.572 : 621.387.4

1124. Nuclear particle and radiation detectors. II. Counters and counting systems. J. SHARPE AND D. TAYLOR. *Instn Elect. Engrs, Paper* 1078, 22 *pp.* [*Early Proof Issue*].

The emphasis is here on the detectors (i.e. the counters in this case), but some details are given of the auxiliary equipment required for a counting system, namely amplifiers, counting-rate meters, scalers and registers, and examples of a number of complete instruments are also given. Proportional, Geiger–Müller and scintillation counters are considered in detail, whilst crystal counters, secondary-emission particle detectors and thermal detectors receive only brief mention. Illustrations of instruments and components are given, and applications are drawn wherever possible from present practice at the Atomic Energy Research Establishment. A.

537.542

1125. Some properties of diamond as a crystal counter. H. ESS AND J. ROSSEL. *Helv. Phys. Acta*, 23 (*No.* 5) 484–7 (1950) *In French.*

537.542 : 537.311.32 : 548.0

1126. Electron current impulses in NaCl-crystals released by α-particles. H. WITT. *Z. Phys.*, **128** (*No.* 3) 442–50 (1950) *In German.*

Measurements with experimental details (6 diagrams) are recorded for the current impulses released by α-particles in NaCl crystals. These impulses increase linearly with the voltage, and are inversely proportional to the concentration of active colour centres which absorb electrons. The ratio of the dissociation probability z_β/z_α of the secondary electrons of α-particles and β-rays is 10 for alkali halide crystals. At least 90% of the electrons liberated by α-particles recombine at a field strength of $1{\cdot}5 \times 10^7$ V/m, and the remainder move freely through the whole crystal. H. H. HODGSON

537.542

1127. The scintillation efficiency of anthracene for low energy electrons. W. J. RAMLER AND M. S. FREEDMAN. *Rev. Sci. Instrum.*, **21**, 784–6 (*Sept.*, 1950).

The efficiency of an anthracene scintillation counter used as the detector in a double magnetic lens beta-ray spectrometer for electrons in the range 0–20 keV has been determined. Monoenergetic electrons generated by an electron gun were focused on the anthracene crystal, the beam being concurrently monitored by an electron collector and electrometer. A.

537.542

1128. Detection of scintillations from crystals with a photo-sensitive Geiger–Müller counter. C. E. MANDEVILLE AND H. O. ALBRECHT. Letter in *Phys. Rev.*, **79**, 1010–11 (*Sept.* 15, 1950).

Describes how, after preliminary experiments with G.M. counters sensitive to visible light, attention was directed to the use of crystals scintillating in the u.v., to enable ordinary G.M. tubes to be used. Various expts. on the counting of α- (efficiencies 15–100%), β- (efficiency 10% in preliminary tests) and γ-rays are described. J. D. CRAGGS

537.542

1129. Detection of beta-induced scintillations from crystals with a photo-sensitive Geiger–Mueller counter. C. E. MANDEVILLE AND H. O. ALBRECHT. Letter in *Phys. Rev.*, **80**, 117 (*Oct.* 1, 1950).

See preceding Abstr.

537.542 : 621.383.8

1130. Multiplier phototubes in scintillation counters. R. E. B. HICKMAN. *Electronic Engng*, **22**, 474–6 (*Nov.*, 1950).

Describes the use of the R.C.A. 5819 multiplier

phototube in conjunction with a crystal of phosphor which emits a flash of light when bombarded with the type of particle which it is desired to count. The characteristics of earlier tubes are tabulated, demonstrating the great improvement in dark current in this tube. A. H. W. BECK

537.542 : 621.317.726.087.6 : 621.3.018.75

1131. Chart recording of microsecond pulse amplitudes. J. T. DEWAN AND K. W. ALLEN. *Rev. Sci. Instrum.*, **21**, 823–6 (*Oct.*, 1950).

A peak voltmeter circuit is described which will record on a chart the amplitudes of μsec pulses generated at random in ionization chambers or similar counters. Slow response of the recording pen prohibits the resolution of pulses less than 1 sec apart. Provision is made for selecting pulses coincident with some triggering event as the low counting rates suitable for the circuit are most often encountered in coincidence experiments. Coincidence resolving times as low as 5 μsec may be attained, and the linearity is such that input pulse amplitudes from 2 to 100 V are reproduced on the chart to within $\pm$ 1 V. A.

537.542

1132. A high-speed short resolving time coincidence circuit for use with scintillation counters. E. F. SCHRADER. Note in *Rev. Sci. Instrum.*, **21**, 883 (*Oct.*, 1950).

537.542 : 621.317.39 : 621.318.572

1133. An improved resolving time measuring device. B. W. ROBERTS, JR., K. E. PERRY AND R. G. FLUHARTY. *Rev. Sci. Instrum.*, **21**, 790–6 (*Sept.*, 1950).

A circuit for measuring resolving times has been developed utilizing the scheme of Curran and Rae [Abstr. 986 (1948)] with the addition of a delayed pulse of variable width. Any random event initiates a delayed pulse which is fed into coincidence with subsequent pulses giving rise to a sharp increase in the coincidence rate at a delay time close to the resolving time. A theory is given which predicts observed curve shapes and data are given for several counters to illustrate the operation under different counting rates and overvoltages. A.

537.542 : 621.318.572

1134. Differential counting in pulse amplitude analysis. G. VALLADAS AND J. THÉNARD. *J. Phys. Radium*, **11**, 501–6 (*Aug.–Sept.*, 1950) *In French.*

Reviews previous instruments and describes a new one with a resolving time of 10–20 μsec which accepts pulses with a rise-time > 1 μsec. If the thresholds of two adjacent channels are V_1, V_2 volts ($V_2 > V_1$); a pulse of amplitude V, ($V_1 < V < V_2$) is recorded by both channels, but the operation of the upper channel is used to block the lower so that the next pulse which otherwise would operate it is not counted. A. O. STANESBY (R)

IONIZATION . THERMIONICS 537.56/.58

537.56

1135. Ionization and dissociation by electron impact: cyanogen, hydrogen cyanide, and cyanogen chloride and the dissociation energy of cyanogen. D. P. STEVENSON. *J. Chem. Phys.*, **18**, 1347–50 (*Oct.*, 1950).

The appearance potentials of CN^+ in the mass spectra of HCN and $(CN)_2$ have been remeasured and found to be $19{\cdot}3_6 \pm 0{\cdot}2$ and $20{\cdot}3_1 \pm 0{\cdot}2$ eV, respectively. Combination of the appropriate thermochemical data with the difference between these energies yields, $D(NC - CN) = 6{\cdot}8_8 - 2E(Z)$ eV, where Z is the state of the CN radical either $X^2\Sigma^+$ or $A^2\Pi_i$, that accompanies CN^+ from $(CN)_2$, and $E(X^2\Sigma^+) = 0{\cdot}00$ eV and $E(A^2\Pi_i) = 1{\cdot}13$ eV. The appearance potential of Cl^+ in the mass spectrum of ClCN has also been measured and found to be $17{\cdot}8_1 \pm 0{\cdot}2$ eV, which value gives $D(NC - CN) = 6{\cdot}9_2 - 2E(Y)$ when combined with the spectroscopic ionization potential of the Cl atom and the necessary thermochemical data. Here Y is the state of the CN radical that accompanies Cl^+ from ClCN. In order that the two determinations of $D(NC - CN)$ be consistent it is necessary that $Y = Z$ and then the two permissible values of $D(NC - CN)$ are $6{\cdot}9_0 \pm 0{\cdot}2$ eV ($Y = Z = X^2\Sigma^+$) or $4{\cdot}6_4 \pm 0{\cdot}2$ eV ($Y = Z = A^2\Pi_i$). These results do not permit a choice between White's determination, $6{\cdot}3 \pm 0{\cdot}2$ eV, and Pauling's estimate, $3{\cdot}9 \pm 0{\cdot}6$ eV, but do serve to eliminate from further consideration the determination by Kistiakowsky and Gershinowitz, 3·3 eV. Neither value is compatible with the 5·2 eV suggested by Glockler. However, electron impact data on ethylene and methylene radical give 5·6 eV as the upper limit to energy of dissociation of ethylene into two methylene radicals, and this can be taken as an upper limit to the dissociation energy of cyanogen, suggesting the lower of the two possible values of $D(NC - CN)$ to be correct. Corresponding to this lower value of $D(NC - CN)$, $4{\cdot}6_4 \pm 0{\cdot}2$ eV, the dissociation energies of H — CN and Cl — CN are $4{\cdot}8_0 \pm 0{\cdot}1$ and $3{\cdot}6_6 \pm 0{\cdot}1$ eV, respectively, and the ionization potential of CN is $14{\cdot}5_5 \pm 0{\cdot}2$ eV. The specific intensities of the various ions in the mass spectra of $(CN)_2$, HCN and ClCN characteristic of 75-volt ionizing electrons are given with reference to that of A^+ in the A mass spectrum. A.

537.56

1136. Dissociation cross sections for fast hydrogen molecule ions. E. E. SALPETER. Letter in *Proc. Phys. Soc. Lond. A*, **63**, 1295–7 (*Nov.*, 1950).

An approximate value for these is found for H_2^+ of energy 1–20 MeV in collision with stationary gas molecules or atoms. As estimates the sum is taken of (i) twice the total cross-section for 1 free proton of the same velocity as the H_2^+ ion, undergoing a momentum change of $(2mE_N)^{\frac{1}{2}}$, (ii) the total cross-section for 1 free electron of the same velocity, momentum change $> (2mE_e)^{\frac{1}{2}}$ or $(2mE_e')^{\frac{1}{2}}$. The dissociation energies of H_2^+ are, according to the excitation: $E_N(2{\cdot}8$ eV) for nuclear vibrations, $E_e(12{\cdot}5$ eV) for higher electronic states, $E_e'(\geqslant 30$ eV) for a continuum state. The cross-sections σ for stationary H, N, O, A or H_2, N_2, O_2 show that σ varies with the atomic number Z of the hit atom, proportional to between Z and Z^2. J. JACOBS

537.561

1137. Probabilities of excitation and de-excitation of metastable states of oxygen atom by collision of

slow electron. T. YAMANOUCHI. *J. Phys. Soc., Japan*, **5**, 154–7 (*May–June*, 1950).

Numerical values are obtained from approximate wave-mechanical calculations. A. G. GAYDON

537.561 : 53.081.6

1138. A new determination of *h/e*. C. L. HEMENWAY AND F. G. DUNNINGTON. Letter in *Phys. Rev.*, **79**, 887–8 (*Sept.* 1, 1950).

By measurement of an excitation potential of He by electron bombardment. Tentative result: $1{\cdot}37902 \pm 0{\cdot}00035 \times 10^{-17}$ erg sec/e.s.u. [See also Abstr. 1084 (1951)].

537.561 : 539.133

1139. Ionization and dissociation by electron impact in methane, methyl alcohol and methylal. J. GEERK AND H. NEUERT. *Z. Naturforsch.*, **5a**, 502–4 (*Sept.*, 1950) *In German.*

Critical potentials for various dissociation processes occurring in the above gases (CH_4, CH_3OH and $CH_2(OCH_3)_2$) were measured in a mass spectrometer. Tables of results are given, with a short discussion of various dissociation processes. J. D. CRAGGS

537.562

1140. The work per ion pair in gas mixtures for α-particles. W. HAEBERLI, P. HUBER AND E. BALDINGER. *Helv. Phys. Acta*, **23** (*No.* 5) 481–4 (1950) *In German.*

Measurements on the energy necessary to produce an ion pair in mixtures of N_2, O_2, He and A are made with U α-particles under conditions of charge saturation. It is found that the mixtures do not behave as though each component was independently ionized; the interaction is ascribed to light quanta and δ-electrons. J. HUGHES

537.562

1141. The specific ionization curves for hydrogen and deuterium. T. N. HATFIELD, A. E. LOCKENVITZ AND J. M. YOUNG. *J. Franklin Inst.*, **250**, 309–14 (*Oct.*, 1950).

The specific ionization (Bragg) curves are obtained for H and D, with alpha particles from Po as the ionizing source. The curves are found to coincide quite closely and the stopping powers as determined from the curves are the same for both gases. A.

537.562 : 621.315.61 : 621.3.011.5

1142. Ionization processes in solid insulators. B. HELLER AND J. VEVERKA. *Elektrotech. Obz.*, **39**, 229–34 (*June*, 1950) *In Czech.*

The theory of ionization processes is developed on a model of an actual solid insulator having gas-filled pores. These cavities are regarded as spark-gaps across which intermittent discharges may be produced. Such a medium may be represented by an equivalent circuit (hence numerous combinations of circuit elements may be chosen), in the particular case considered, they consist of two capacitors in series, the larger of which is bridged by a spark gap with series resistance. The processes in the spark gap under various operating conditions are then investigated theoretically and experimentally on a model circuit. The oscillograms taken correspond in character to those obtained on a solid insulator, provided that the series resistor in the model circuit is small. The experiments were extended to include behaviour of the loss angle, the relation of which to applied voltage had been derived theoretically. B. F. KRAUS

537.564 : 539.164.81

1143. Ionization by recoil particles from alpha-decay. R. C. LING AND J. K. KNIPP. Letter in *Phys. Rev.*, **80**, 106 (*Oct.* 1, 1950).

537.565 : 539.133

1144. Ionic mobilities and the electric quadrupole moment of N_2. M. H. JOHNSON. Letter in *Phys. Rev.*, **80**, 101 (*Oct.* 1, 1950).

537.583

1145. Thermionic properties and activation of thoria. G. MESNARD. *C.R. Acad. Sci., Paris*, **231**, 768–70 (*Oct.* 16, 1950) *In French.*

The emission from thoria cataphoretically coated on W wires was studied. The emission depends greatly on the activation procedure. Activation first takes place, suddenly, at temperatures about 1950 K ($Is > 0{\cdot}5A/cm^2$ at 1 900°K). ϕ and A are both small. Increasing the activation temperature increases A and ϕ until at 2 650°K, $A = 100\ A/cm^2$ $\phi > 2{\cdot}5$ eV ($Is > 3{\cdot}0\ A/cm^2$ at 1 900°K). These activities are reduced by the use of collodion. It is thought that the heat treatment of the initially amorphous thoria produces crystal growth with excess Th. This process was studied by X-ray diffraction and confirmed the hypothesis. The max. operating temp. for reasonable life is about 2 000°K. A. H. W. BECK

537.583

1146. Thermo-electronic processes in thoria cathodes. G. MESNARD. *C.R. Acad. Sci., Paris*, **231**, 833–5 (*Oct.* 23, 1950) *In French.*

The operation of the thoria cathode is discussed from the viewpoint of a dynamic equilibrium between production of Th on the one hand and diffusion and evaporation on the other. The bearing of the measurements of other constants, e.g. the spectral emissivity and electric conductivity at low temperatures is indicated. A. H. W. BECK

537.583 : 621.385.1.032.216

1147. On the thoria coated cathode. T. ARIZUMI AND L. ESAKI. *J. Phys. Soc. Japan*, **5**, 163–9 (*May–June*, 1950).

Describes tests made on cathodes prepared by cataphoretically coating W wire with thoria. Three types of cathode were tested: (1) white (activated by flashing to 2 000–2 000°K for 15 min); (2) grey (activated similarly at above 2 500°K); (3) black (activated in CH_4). The work functions were: (1) 3·2 eV; (2) 3·2 eV below 1 200°K, 1·95 eV above; (3) 1·9 eV from 1 000–1 400°K. No. 2 is easily poisoned by O_2. The decay and recovery of emission were studied and a value of 0·3 eV deduced for the diffusion energy of Th atoms. A. H. W. BECK (R)

537.583 : 621.385.1.032.216

1148. Conductivity and electronic energy state of thoria coated cathode. T. ARIZUMI AND L. ESAKI. *J. Phys. Soc. Japan*, **5**, 174–7 (*May–June*, 1950).

Probe measurements were made on the conductivity of the thoria coating. The conductivity curve was found to be parallel to the thermionic emission curve, the values being about 1·8 and 2·5 eV respectively. From these results and those of the preceding Abstr.

it is concluded that thoria is an *N*-type semi-conductor with a surface work function of 0·7 eV and an impurity level which is 2·5 eV below the conduction band when inactive and 1·25 eV when fully active.

A. H. W. BECK (R)

537.583 : 621.385.1.032.216

1149. Emissivity changes of thoria cathodes. O. A. WEINREICH. *J. Appl. Phys.*, **21**, 1272–5 (*Dec.*, 1950).

Spectral and total emissivity measurements of thoria-coated W filaments show that irreversible and reversible changes of the emissivity occur. ε_λ ($\lambda = 0{\cdot}65\ \mu$) varies from 0·2 to 0·7 and ε_t from 0·2 to 0·5. Certain variations of the thermal radiation can be related to changes of thermionic emission. Passage of current through the coating affects emissivity and thermionic emission. This is shown by measuring i.r. radiation and electron current simultaneously. The existing relationship between emissivity and thermionic activation is discussed. A.

COSMIC RAYS 537.591

537.591.1

1150. The heavy primary nuclei of cosmic rays. T.-F. HOANG. *Ann. Phys., Paris*, **5**, 537-95 (*Sept.–Oct.*, 1950) *In French.*

Measurements on 123 heavy cosmic ray particles, $Z > 2$, observed in Ilford G.5 emulsion exposed by means of a balloon at 22 km altitude are reported. The incident flux of heavy particles, their distribution in atomic number and their range in air are examined. The heaviest particle observed is estimated to be of $Z \sim 34$. The application of δ-ray counting to these tracks is treated, and notable events discussed.

J. G. WILSON

537.591.1

1151. The meson spectrum and meteorological variations in cosmic-ray intensity. D. C. ROSE. Letter in *Phys. Rev.*, **80**, 106–7 (*Oct.* 1, 1950).

The barometer coefficient was measured at Ottawa and Resalute, with 2 Pb-shielded telescopes at each place. One telescope accepts mesons of momentum > 300 MeV/c, the other > 600 MeV/c. The barometer coefficient was consistently smaller at lower momentum. The results are compared with various predictions based on a power spectrum at production and decay in the atmosphere. E. P. GEORGE

537.591.1

1152. Erratum: On the primary cosmic-ray spectrum. J. A. VAN ALLEN AND S. F. SINGER. Letter in *Phys. Rev.*, **80**, 116 (*Oct.* 1, 1950).

See Abstr. 8087 (1950).

537.591.1

1153. Energy and density distribution of cosmic-ray neutrons. W. O. DAVIS. *Phys. Rev.*, **80**, 150–4 (*Oct.* 15, 1950).

The theory of atmospheric neutron measurements is reviewed in the light of recent data on neutron scattering and capture cross-sections in air and B. It is concluded that the mean energy of atmospheric neutrons is 0·26 eV rather than the previous value of 0·06 calculated by Bethe, Korff and Placzek. The spatial distribution is then recalculated and found to agree closely with earlier calculations by Flügge. Recent measurements of neutron intensity as function of altitude are discussed in the light of the foregoing and are found to offer confirmation of the new calculations. A

537.591.1

1154. The mean square deviation of the number of electrons and quanta in the cascade theory. H. J. BHABHA AND A. RAMAKRISHNAN. *Proc. Indian Acad. Sci. A*, **32**, 141–53 (*Sept.*, 1950).

On the basis of the quantum mechanical cross-sections for radiation emission by electrons and pair creation by quanta when screening is complete, the fluctuation in the mean number of electrons and photons in any given energy interval in a cascade is calculated. The expression for the mean square deviation of this number is given explicitly in the form of a double integral which can be evaluated by the saddle-point method. A

537.591.15

1155. Extensive air showers and total cosmic radiation. G. COCCONI. Letter in *Phys. Rev.*, **79**, 1006–7 (*Sept.* 15, 1950).

The flux of electrons, μ-mesons and nucleons in extensive showers of density $> 0{\cdot}5\ \mathrm{m}^{-2}$ is evaluated and found to amount to the following fractions of the total fluxes of these particles: 1/11, 1/1 600, 1/1 300. It is argued that when account is taken of showers of lower density, it may well be that the total flux of these particles originate in extensive showers.

E. P. GEORGE

537.591.15

1156. A mixed shower of nuclear origin. M. S. SINHA. Letter in *Phys. Rev.*, **79**, 1025–6 (*Sept.* 15, 1950).

Two showers were observed to diverge in opposite directions from a point in a Pb plate in a cloud chamber. The showers are explained in terms of an explosive, rather than a cascade process.

E. P. GEORGE

537.591.15

1157. Rossi curve for showers of many particles. G. CARMOUZE AND J. DAUDIN. *C.R. Acad. Sci., Paris*, **231**, 572–4 (*Sept.* 18, 1950) *In French.*

The Rossi curve for showers of at least four particles in thin layers of absorber, and not associated with extensive air showers, is determined at 2 860 m altitude to determine whether such showers are in fact nuclear explosions. The curve is of normal form and shows horizontal tangent at zero thickness. The showers not associated with extensive showers are thus also of electronic type. Deviations from the predicted (Arley) curve are attributed to the omission of the energy variation of pair-production in the theoretical treatment. J. G. WILSON

537.591.15

1158. Note on the complete stochastic treatment of electron cascades. H. J. BHABHA. *Proc. Indian Acad. Sci. A*, **32**, 154–61 (*Sept.*, 1950).

The present note extends to the actual cascade process a result already established by Scott and Uhlenbeck for a model in which there is only one type of physical entity involved. It is shown that

with the sole approximation of neglecting the angular divergence of showers complete information about the stochastic process of cascade generation can be calculated. The qth order correlation functions are expressed as integrals involving the $(q-1)$th order correlation functions and the two independent elementary solutions of the cascade equations. The latter are the usual functions giving the mean number of electrons and photons in cascades excited respectively by a single electron or photon of some definite energy. If the latter are known exactly, then all the higher order correlation functions can be calculated by repeated integration. One thus obtains explicit expressions for the mean of the qth power of the number of electrons or photons in some finite energy interval, and from this again of the probability of finding N particles in this energy interval at a depth t in a cascade started by an electron or photon of some given energy. A.

537.591.15

1159. Origin of Rossi showers under thick screens of heavy material. A. Fréon and Tsai-Chu. *C.R. Acad. Sci., Paris*, **231**, 850–1 (*Oct.* 23, 1950) *In French.*

The barometer effect of Rossi showers near sea level under 2 cm Pb (cascade maximum) and under 18 cm Pb have been measured to be respectively $(-2{\cdot}6\pm1)\%\text{cm}^{-1}$ Hg and $(-6{\cdot}25\pm0{\cdot}7)\%\,\text{cm}^{-1}$ Hg. The value under 2 cm Pb is closely that of the meson component, that under 18 cm Pb is intermediate between that of mesons and that of nucleons. A measurement with similar apparatus at Pic du Midi (2 900 m), under 10 cm Pb shows an increase over the sea-level rate which is greater than that of the penetrating component. Nucleons thus appear to contribute to Rossi showers under 18 cm Pb even at sea-level. J. G. Wilson

537.591.15

1160. Penetrating particles in air showers. C. B. A. McCusker. *Proc. Phys. Soc. Lond. A*, **63**, 1240–7 (*Nov.*, 1950).

The penetrating particles in extensive air showers are compared directly with the penetrating particles in the main cosmic-ray beam. It is found that not more than $70\pm3\%$ of the air-shower particles are single μ-mesons, whilst the remainder are strongly interacting particles. The barometer coefficient of extensive penetrating showers is determined. A.

537.591.5

1161. Remarks on the latitude effect of cosmic rays at sea-level. H. D. Rathgeber. *Aust. J. Sci. Res. A*, **3**, 183–92 (*June*, 1950).

During a recent voyage from Australia to Japan the intensity of cosmic rays was measured with several Geiger counter telescopes of different designs. The conclusions to be drawn from these and other results are presented in this paper. It is shown that the latitude effect at sea-level (averaged over all azimuths) is approximately proportional to $\cos^2 1{\cdot}2\,\zeta$, where ζ is the zenith angle of the incident radiation, and that the vertical latitude effect is 18%. In general, the latitude effect depends both on zenith angle and azimuth. The phenomenological relationships of these intensity variations with the zenith angle distribution at 2 fixed locations, i.e. at high latitudes and at the equator, and with the east-west effect at the equator, are deduced. After correction for longitude and zenith angle, Geiger counter telescope and ionization measurements do not differ by more than their errors of measurements; the average specific ionization does not vary with latitude. Qualitative explanations of the equality of the latitude effects for mesons and for electrons, as well as of the latitude effect of small extensive showers are given. A.

537.591.5

1162. High altitude intensity of penetrating cosmic rays at Poona 9° N. (mag.). K. S. Chandrasekharen, G. S. Gokhale and A. S. Rao. *Proc. Indian Acad. Sci. A*, **32**, 95–7 (*Aug.*, 1950).

Experiments were conducted with quadruple-coincidence counter telescopes with 10 cm of Pb between the counters, using the radiosonde technique. Heights of 60 000 ft (100 mb) were reached. It is concluded that the intensity of cosmic radiation penetrating 10 cm of Pb absorber increases monotonically with decreasing atmospheric pressure. A.

537.591.5

1163. Cosmic ray intensity measurement at Bangalore 3° N (mag.). G. S. Gokhale, A. W. Pereira and A. S. Rao. *Proc. Indian Acad. Sci. A*, **32**, 98–104 (*Aug.*, 1950).

Total vertical intensity was obtained with quadruple-coincidence telescopes with double-counter trays up to an altitude of 27·5 km. The vertical intensity of cosmic radiation penetrating 10 cm of Pb was measured by quadruple-coincidence telescopes with single-counter trays and with double-counter trays. The intensity of the penetrating component increases monotonically with altitude in all the flights, but the ratio of the intensity at 100 mb level to that at ground level differs by as much as 50% from flight to flight, although the ground intensity agrees in all cases to within 3%, and the measurements were made with standard telescopes. A.

537.591.5

1164. The primary specific ionization and intensity of the cosmic radiation above the atmosphere at the geomagnetic equator. S. F. Singer. *Phys. Rev.*, **80**, 47–51 (*Oct.* 1, 1950).

Directional intensities and the primary specific ionization of the charged cosmic-ray flux above the atmosphere were measured by means of a G.M. counter telescope in an Aerobee sounding rocket launched at the geomagnetic equator. The intensity at a zenith angle of 45° averaged over all azimuths, was found to be $0{\cdot}04$ particle $\text{sec}^{-1}\,\text{cm}^{-2}$ steradian^{-1}, of which not more than 65% can be attributed to primaries, the remainder being due to albedo. The low value ($\sim 40\%$) of the observed east-west asymmetry is most directly explainable in terms of positive proton primaries and a large albedo flux at large zenith angles, although a small contribution of negative primaries cannot be excluded. The primary specific ionization of the radiation above the atmosphere is found to be essentially the same as that of the sea-level radiation, indicating a predominance of singly-charged particles of near minimum ionization. This result strongly suggests that the albedo radiation

at the equator does not consist of low energy (< 100 MeV) protons. Most of the properties of bursts produced in a small Pb block can be accounted for reasonably in terms of known initiating particles and interactions. A.

537.591.5

1165. A determination of the high altitude latitude dependence in cosmic-ray neutron intensity. W. P. STAKER. *Phys. Rev.*, **80**, 52–7 (*Oct.* 1, 1950).

High altitude flights have been made with balloon-borne neutron-detecting equipment at 30·4°N and 54·7°N geomagnetic latitudes. A maximum neutron density was found at an absorption depth of 110 g/cm² at 30·4°N and 100 g/cm² at 54·7°N. The maximum neutron density at 54·7°N is approximately 2·9 times as great as the maximum neutron density measured at 30·4°N. The total integrated neutron density at 54·7°N is approximately 2·4 times as large as that at 30·4°N. These results indicate a greater latitude effect for neutron densities than for total ionization, but less than for primary particles, thus corroborating present theories of neutron formation. A.

537.591.5

1166. Observations in photographic emulsions of the anisotropy of cosmic rays at high altitude. P. DEMERS, R. COURTEMANCHE AND G. LAMARCHE. *C.R. Acad. Sci., Paris*, **231**, 651–3 (*Oct.* 2, 1950) *In French.*

Piles of unsupported photographic emulsion in which tracks may be followed from one emulsion to another were flown between 14 and 26 km altitude in known orientation at 57° geomagnetic N latitude. Isolated heavy tracks and tracks which are probably star primaries show a distribution consistent with positive charge; other tracks are considered to be star products maintaining the direction of primary.

J. G. WILSON

537.591.5

1167. Altitude and latitude dependence of bursts in a lead-shielded ionization chamber. A. J. MCMAHON, B. ROSSI AND W. F. BURDITT. *Phys. Rev.*, **80**, 157–63 (*Oct.* 15, 1950).

The instrument used consisted of a cylindrical ionization chamber covered by a half-cylindrical 15-cm thick Pb shell. Five trays of G.M. tubes were placed around the shell and one tray directly below the ionization chamber. Various kinds of coincidences were recorded between bursts of ionization in the chamber and discharges of the G.M. tubes. This equipment was flown in a B-29 at Rome, New York (geomagnetic latitude 55°N), and at Panama (geomagnetic latitude 20°N). The experiment provided information on the altitude, latitude and angular dependence of the radiation responsible for the observed events. These were interpreted as due to nuclear interactions by nucleons of different energies. In particular, for events attributed to protons with an estimated minimum energy of about 5 BeV the intensity ratio between 55°N and 20°N at 30 500 ft was $1·17 \pm 0·04$. In contrast, for events attributed to protons with an estimated minimum energy of about 0·4 BeV the latitude ratio at the same altitude was $1·96 \pm 0·18$. A.

537.591

1168. Latitude effect of cosmic ray stars in photographic emulsions. M. MORAND, C. BEETS AN L. WINAND. *C.R. Acad. Sci., Paris*, **231**, 851 (*Oct.* 23, 1950) *In French.*

The rates of star production, for stars of three o more branches, in Ilford $C_3 + B$ emulsion near t geomagnetic equator and at 49°N geomagnet latitude are compared for altitudes 1 600 m an 4 500 m. At 1 600 m there is no significant increas of rate at the high latitude; at 4 500 m the increase estimated to be $(1·9 \pm 0·4)$. The significance o these results, in terms of the higher mean primar energy at the equator, is briefly examined.

J. G. WILSO

537.591.

1169. Observations of cosmic-ray events in nuclea emulsions exposed below ground. E. P. GEORGE AN J. EVANS. *Proc. Phys. Soc., Lond. A*, **63**, 1248–6 (*Nov.*, 1950).

Ilford Nuclear research plates were manufacture in a laboratory at an equivalent depth of 60 m o water below ground. After having been stored a various depths, the plates were processed belo ground. The observed frequencies of μ-meson stopped in the plates are consistent with those expecte from measurements on the energy-spectrum of cosmi rays. Several π-mesons stopping in the plates wer observed, and reasons for believing these to have bee locally produced in the matter near the plates ar discussed. Forty-two nuclear disintegrations hav been observed, the frequency at a depth of 60 m water equivalent being of the order of $5 \times 10^{-}$ stars/cm³/day. Approximately one-third of these ar attributed to the electromagnetic interaction o μ-mesons on their passage through nuclei. Th remainder are attributed in part to neutrons from thi first group of stars, and in part to the photons of th soft component underground. Four examples o stars accompanied by showers of particles at mini mum ionization have been observed, and ar discussed. A

537.591.

1170. Double stars due to cosmic rays. T. T. L *Phil. Mag.*, **41**, 1152–60 (*Nov.*, 1950).

Cosmic-ray stars are distributed at random over a photographic plate when distances exceeding 1 cm are considered. For small distances of the order o 1 mm the number of close pairs exceeds that expected on a random distribution. The effect is not found on plates exposed at sea-level and there is some evidence that it is more marked if dense matter surrounds the plates. Several mechanisms are suggested to account for the effect but none is free from objection. A.

MAGNETISM 538

538.081.3

1171. Definition of magnetic units. J. FISCHER. *Ann. Phys., Lpz.*, **8** (*No.* 1–2) 55–64 (1950) *In German.*

Discusses the question whether the force and

ouple acting on a magnet are to be defined in terms f the field strength or of the induction.

E. P. WOHLFARTH

538.082.741 : 621.317.42

172. Detector for very weak magnetic fields and its pplications in electron microscopy. R. BERNARD AND . DAVOINE. *C.R. Acad. Sci., Paris*, **231,** 687–8 *Oct.* 9, 1950) *In French.*

A search coil 5 cm in diameter with 20 000 turns s used with a 2-stage electronic amplifier to measure ne disturbing field limiting the authors' electrostatic lectron microscope. The apparatus is capable of etecting 10^{-5} Oe. With its aid, the resolving limit vas reduced from 50 to 20 Å. It is stated that a cold-athode discharge provides a sufficiently mono-hromatic source for use in h.v. electron microscopy.

H. J. H. STARKS

538.122 : 621.3.013.2

173. The production of pulsed magnetic fields using ondenser energy storage. K. S. W. CHAMPION. *roc. Phys. Soc., Lond. B*, **63,** 795–806 (*Oct.*, 1950).

By means of an electronic switch a condenser harged to a high voltage is connected to an in-uctance and then disconnected after exactly one ycle of oscillation. In this way all the stored energy s used to produce the magnetic field, while most of it returned to the condenser at the end of the cycle, ne only appreciable losses being due to the resistance f the coil and switch. Calculations are made and urves presented for a system in which a uniform nagnetic field is produced within a cylinder. Account taken of the heating of the coil, mechanical stresses n it and the choice of optimum shape. The spatial ariation in the magnetic field is also investigated. n actual apparatus described uses an ignitron to onnect a 25 kV 7 μF condenser to a 2·9 cm i.d. coil 0 cm long, having 3 410 turns of 17 s.w.g. wire. Vith a pulse length (full period) of 10·7 msec, = 22 700 gauss.

S. C. DUNN

538.123 : 621.3.015.1 : 621.3.011.1

174. A method for the mapping of vector potential istributions in axially symmetrical systems. G. LIEB-ANN. *Phil. Mag.*, **41,** 1143–51 (*Nov.*, 1950).

The magnetic vector potential distribution in axially ymmetrical systems containing current-carrying onductors and Fe of arbitrary shape can be obtained xperimentally with good accuracy using resistor net-orks. Two networks are possible, one for plotting ne flux function rA_θ and one for plotting the vector otential A_θ itself. The latter one is a modification a field-plotting network described previously. ome confirming measurements on a model of an finitely long coil were carried out.

A.

538.21 : 538.65

175. The couple acting on a permanent magnet in e field of a permeable medium. A. SOMMERFELD ND E. RAMBERG. *Ann. Phys., Lpz.*, **8** (*No.* 1–2) –54 (1950) *In German.*

The boundary value problem is solved for a long, niformly magnetized ellipsoid of revolution in a niform field of arbitrary direction. The couple is lculated using a modified strain tensor. The niting case of a bar magnet is discussed. The general ellipsoid is treated in the case where the permeability of the magnet equals that of its surroundings.

E. P. WOHLFARTH

538.214 : 538.69 : 548.0

1176. The de Haas–van Alphen effect. R. B. DINGLE AND D. SHOENBERG. Letter in *Nature, Lond.*, **166,** 652–3 (*Oct.* 14, 1950).

An account of new results on the de Haas–van Alphen effect in Ga, Sn and graphite at fields up to 15 800 gauss and at temperatures down to 1·1°K. The theory of the effect has been reconsidered. The characteristics of the effect are different for the 3 principal axes of a crystal of Ga and are much more complicated than was originally suggested. The theory has been extended to consider the influence of collision-broadening of the energy levels in a magnetic field, and now provides an explanation of many experimental features previously unexplained.

A. E. DE BARR

538.221

1177. The magnetic moments and Curie points of hexagonal and cubic cobalt. A.-J.-P. MEYER AND P. TAGLANG. *C.R. Acad. Sci., Paris*, **231,** 612–14 (*Sept.* 25, 1950) *In French.*

An estimate is made of the saturation moment of cubic Co by extrapolating a previously observed curve [*C.R. Acad. Sci., Paris*, **229,** 704–7 (*Oct.* 10, 1949)], relating the moment with Co concentration for FeNi–Co alloys, to 100% Co. The moment is found to be 1·745 μ_B, cf. 1·70 μ_B for hexagonal Co. From the observed linear variation between magnetic moment and Curie temperature, the value of the latter is estimated to be 1 070°K for hexagonal Co, cf. 1 404°K for cubic Co.

E. P. WOHLFARTH

538.221

1178. Ferromagnetism at very high frequencies. III. Two mechanisms of dispersion in a ferrite. G. T. RADO, R. W. WRIGHT AND W. H. EMERSON. *Phys. Rev.*, **80,** 273–80 (*Oct.* 15, 1950).

The magnetic spectrum of a ferrite is shown to contain two regions of pronounced dispersion. One occurs at radiofrequencies, resembles a resonance, and is proved to be due to domain wall displacements; the other occurs in the microwave range, exhibits typical resonance characteristics, and is attributed to domain rotations. The identification of the dispersion mechanisms is based primarily on a comparison of the complex permeability of solid samples with that of small particles of the same material. Several manifestations of single-domain behaviour are reported, and a study of remanence by high frequency methods is presented. The wall effects are interpreted in terms of the concept of apparent wall inertia and it is shown that microscopic eddy currents cannot cause the damping. The rotational effects are interpreted on the basis of crystalline anisotropy. Previously used methods for identifying dispersion mechanisms are discussed.

A.

538.221 : 621.318.32

1179. Ferromagnetic spinels for radio frequencies. R. L. HARVEY, I. J. HEGYI AND H. W. LEVERENZ. *RCA Rev.*, **11,** 321–63 (*Sept.*, 1950).

Ferrospinels are unique crystalline materials of

spinel structure which are formed at high temperatures by solid-phase reaction of iron oxide and one or more of certain other metal oxides. They are ceramic-like ferromagnetic materials characterized by high permeability (up to greater than 1 200), high electric resistivity (up to $10^8\ \Omega$ cm), and low losses at r.f. Wide ranges in these and other properties are obtainable by varying the component ingredients and methods of synthesis. An outline is given of the elementary theory of ferromagnetism, and descriptions of the structures, synthesis, properties and uses of some practical ferrospinels. A.

538.222

1180. Magnetic susceptibilities of urania–thoria solid solutions. W. Trzebiatowski and P. W. Selwood. *J. Amer. Chem. Soc.*, **72**, 4504–6 (*Oct.*, 1950).

The magnetic moment of tetravalent U has been determined in solid solutions of UO_2 with diamagnetic ThO_2 in the concentration range 100 to 2% urania. The molar susceptibility of the uranium rises sharply with increasing magnetic dilution, but this is due almost entirely to a diminution of the Weiss constant. The magnetic moment of the U shows little, if any, dependence on concentration. The moment at the greatest dilution is in agreement with the "spin only" formula for two unpaired electrons, and hence with the 6*d* rather than the 5*f* electron distribution. A.

538.222

1181. The magnetic susceptibility of tungsten bronzes. F. Kupka and M. J. Sienko. Letter in *J. Chem. Phys.*, **18**, 1296–7 (*Sept.*, 1950).

538.222

1182. Microwave magnetic resonance absorption in nitrogen dioxide. J. G. Castle, Jr., and R. Beringer. Letter in *Phys. Rev.*, **80**, 114–15 (*Oct.* 1, 1950).

538.222 : 536.7

1183. The nuclear specific heat in paramagnetic cupric salts at temperatures below 1°K. I. Thermodynamic measurements made from a study of the field-dependence of the adiabatic susceptibility. C. G. B. Garrett. *Proc. Roy. Soc. A*, 375–91 (*Oct.* 10, 1950).

Thermodynamic measurements have been made at temperatures below 1°K, obtained by the method of magnetic cooling, on copper potassium sulphate and on a diluted copper Tutton salt. A study has been made of the field-dependence (for small fields) of the adiabatic susceptibility of the cooled and thermally isolated salt, the measurements covering the range of temperature from 1°K down to 0·05°K for copper potassium sulphate, and to 0·025°K for the dilute salt. From these measurements the entropy and magnetic susceptibility are determined as functions of the absolute temperature. It is concluded that for both salts the susceptibility follows a Curie–Weiss law, the values of Δ being 0·034 and 0·0048°K respectively; the specific heats are of the form A/T^2, the values found for A being $6{\cdot}1\times10^{-4}\ R$ for copper potassium sulphate and $1{\cdot}98\times10^{-4}\ R$ for the dilute salt. Deviations from this behaviour in a ferromagnetic direction are found for copper potassium sulphate below 0·07°K. A.

538.222 : 536

1184. The nuclear specific heat in paramagnet cupric salts at temperatures below 1°K. II. The nucle specific heat. C. G. B. Garrett. *Proc. Roy. Soc.* 392–9 (*Oct.* 10, 1950).

A theoretical discussion of results in precedi Abstr. Contributions to the low-temperature specif heat from dipole-dipole and exchange interaction a shown to depend linearly on the dilution factor whe dilution has occurred in a purely random manne From a comparison of the results for the diluted an undiluted salts it is shown that a part of the specif heat is independent of the degree of dilution. Th part is identified with the nuclear specific heat expecte from nuclear-electronic interaction within the ator The interaction constants are evaluated and are of th order of 0·01°K. These results are in agreement wi observations of the hyperfine structure in dilute copp salts made from paramagnetic resonance experiment The effect of exchange interaction is also discussed.

538.222 : 539.153 : 538.5

1185. Paramagnetic resonance and dispersio R. Lacroix, C. Ryter and R. Extermann. *Hel Phys. Acta*, **23** (*No.* 5) 537–8 (1950) *In French.*

Results are given of susceptibility measurements 9·315 Mc/s on $MnSO_4 . 4H_2O$ and $MnCl_2 . 4H_2$ under magnetic fields up to 10 000 OE. G. F. Hodsma

538.

1186. Magnetization of single crystal plates of silic steel in weak fields. E. Tatsumoto. *J. Sci. Hiroshi Univ., Ser. A*, **14**, 135–46 (*March*, 1950).

Hysteresis curves were obtained for 1·23% Fe– single crystals, both in the form of narrow plates a in picture-frame form. The results differ in son respects from those obtained by Williams [*Phys. Re* **52**, 747, 1004 (1937)]. The effect of tension on t properties of the narrow plate crystals was investigate E. P. Wohlfart

538.

1187. [Hysteresis] properties of ferromagnetic J. Giltay. *Tijdschr. Ned. Radiogenoot.*, **15**, 253– (*July–Sept.*, 1950) *In Dutch.*

A general discussion of the geometry of hystere loops is given. Previous related work by Madelu [*Ann. Phys., Lpz.*, **17**, 865 (1905)] is critically discusse Application is made to magnetic sound recording. E. P. Wohlfart

538.

1188. Mechanism of magnetization in Alnico E. A. Nesbitt and H. J. Williams. Letter in *Phy Rev.*, **80**, 112–13 (*Oct.* 1, 1950).

Powder patterns were obtained on Alnico V spec mens previously heat treated in a magnetic fiel Domain boundaries generally tended to disappear this field was increased. The process of magnetizatio was found to be in the main one of rotation. E. P. Wohlfart

538.

1189. Coercive field of isolated and connected ferr magnetic grains. L. Weil. *C.R. Acad. Sci., Par* **231**, 829–31 (*Oct.* 23, 1950) *In French.*

Compares the magnetic properties of the two typ

of ferromagnetic substance and discusses the properties of an intermediate type, in which the grains are connected by narrow ferromagnetic "bridges." Application is made to the work of Galt [Abstr. 5961 (1950)] on Fe–Ni powders. E. P. WOHLFARTH

538.24

1190. On the Barkhausen jumps in the course of magnetic after-effect. T. HUZIMURA. *J. Phys. Soc. Japan*, **5**, 293–7 (*Sept.–Oct.*, 1950).

Based upon recent theories on the mechanism of magnetization, retardation of the displacement of magnetic domain boundaries has been taken into account in a discussion of this phenomenon. In explaining magnetic after-effect, only gradual changes of magnetization are discussed, but it is not yet clear whether this change is really continuous or not. The author has detected Barkhausen jump in the course of magnetic after-effect under various conditions; a method, and results of, measurement are described, and a discussion on the mechanism of magnetic after-effect is given based upon the results obtained. A.

538.245

1191. Heat changes accompanying magnetization in low and moderate fields: the effects of strain, and a theoretical interpretation. L. F. BATES AND J. H. DAVIS. *Proc. Phys. Soc., Lond. A*, **63**, 1265–82 (*Nov.*, 1950).

The technique of Bates and his co-workers was used to measure the adiabatic temperature changes occurring during magnetization of Ni under conditions of progressively increased internal strain as a pure specimen was taken from the fully annealed state to the state of maximum strain, in absence of deforming force. A new technique enabled accurate thermal curves during virgin magnetization, and in cycles up to 400 oersteds, to be obtained; the induction effect previously reported was investigated and its origin determined. A new theoretical treatment is described in which account is taken of the energy changes associated with magnetostriction and which enables the thermal curves to be calculated from available data on magnetization and magnetostriction, and a general physical interpretation of the curves is given. Agreement is good for strained specimens and an explanation of the less satisfactory agreement for annealed specimens is offered. A.

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3

1192. Electromagnetic ponderomotive forces within material bodies. J. SLEPIAN. *Proc. Nat. Acad. Sci., Wash.*, **36**, 485–97 (*Sept.*, 1950).

One may define as a possible e.m. stress tensor any tensor (whose components are functions of E, D, B, H, ρc, j), which in empty space reduces to the Maxwell stress tensor. One may then define the associated mechanical stress tensor through the vector difference, which must be derivable from a tensor, between the calculated electric force on the sides of a cut along a surface element within the body and the mechanical force observed there. These two largely arbitrary tensors meet all the requirements of mechanics and electromagnetism and the various sets of such possible tensors lead to the same predictions for experimentally verifiable results. There is then no uniquely definable volume and surface e.m. ponderomotive force within a material body. L. PINCHERLE

538.31 : 621.3.013

1193. Fields in and around slots in a magnetic medium, the mechanical forces acting upon the latter in the magnetic field due to an electric current in the slot and the movement of the electric field due to the slot. J. P. SCHOUTEN. *Tijdschr. Ned. Radiogenoot.*, **15**, 163–77 (*July–Sept.*, 1950) *In Dutch.*

Some general propositions are given concerning the electromagnetic field in a slot moving in a homogeneous medium in which an arbitrary external magnetic field is maintained. It is proved that the total electric field in the slot, moving in a homogeneous external field is independent of the inhomogeneity caused by the wall of the slot and of the size and the shape of the slot. The mechanical forces exerted on the slot and electric currents flowing in the slot are also considered. It is proved that the total mechanical force can be calculated just as if the given current field flowed in the homogeneous medium in the given external field, independently of size and shape of the slot. A.

538.32 : 621.3.014

1194. The forces between two conductors. B. D. H. TELLEGEN. *Tijdschr. Ned. Radiogenoot.*, **15**, 157–61 (*July–Sept.*, 1950) *In Dutch.*

The forces between two steady current-carrying conductors can be conceived of as the resultant of fictitious attracting forces and fictitious couples that the elements of current exert on one another; the attracting forces being $\propto$ the scalar product of the current elements divided by their (distance)^2, the couples being $\propto$ the vector product of the current elements divided by their distance. A.

538.52

1195. The calculation of currents induced in a solid sphere. Self-induction and mutual induction with an infinite solenoid. A. COLOMBANI. *C.R. Acad. Sci., Paris*, **231**, 570–2 (*Sept.* 18, 1950) *In French.*

Using the results for a thin spherical shell, approximate expressions are found for the magnetic and electric fields inside and outside a solid conducting sphere placed within a high-frequency solenoid, and coefficients of induction are derived. A. T. PRICE

538.551.5 : 621.317.725

1196. An electronic a.c. differential voltmeter. L. A. ROSENTHAL AND H. S. ZABLOCKI. *Rev. Sci. Instrum.*, **21**, 799–801 (*Sept.*, 1950).

An electronic a.c. differential voltmeter capable of giving a direct reading of the percentage change in voltage in the region of $\pm$ 10% for voltage levels from 1·5 to 150 V and frequencies between 20 and 200 000 c/s, is presented. The instrument is stable in operation, and simple in design. Experimental observations and circuit details are included. A.

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.561 : 621.392.26 : 621.396.671

1197. On the radiation patterns of dielectric rods of circular cross section—the $TM_{0,1}$ mode. C. W. Horton, F. C. Karal, Jr., and C. M. McKinney. *J. Appl. Phys.*, **21**, 1279–83 (*Dec.*, 1950).

The radiation patterns have been measured for 5 dielectric rods of circular cross-section which were excited in the $TM_{0,1}$ mode. These rods were each $0{\cdot}870\ \lambda_0$ in diameter, and the lengths were $2\ \lambda_0$, $4\ \lambda_0$, $6\ \lambda_0$, $8\ \lambda_0$ and $10\ \lambda_0$. The theoretical radiation patterns have been computed by means of equivalent surface electric and magnetic currents. Excellent agreement is obtained when it is assumed that the dia. of the surface on which these currents are distributed is $0{\cdot}65$ of the dia. of the dielectric rod. Representative experimental and theoretical patterns are shown for the full 360°. A.

538.561 : 621.396.671

1198. Theory of collinear antennas. R. King. *J. Appl. Phys.*, **21**, 1232–51 (*Dec.*, 1950).

538.566.2

1199. Investigations on the propagation of sinusoidal electromagnetic waves in stratified media. Application to thin films. F. Abelès. *Ann. Phys., Paris*, **5**, 596–640 (*Sept.–Oct.*, 1950) *In French.*

A mathematical treatment. The medium is supposed to consist of strata of different permeability. Differential equations are derived for the propagation. Expressions are found for the coefficients of reflection and transmission and for the phase changes. Two cases are treated, (1) that in which the thickness of the stratified layer is small compared with the radiation wavelength, and (2) that in which there is a very slow variation within the stratified layer, a typical case being a thin film exhibiting inhomogeneity. A number of general theorems are deduced. Periodically stratified layers are also discussed and a number of appropriate formulae derived for such cases.

S. TOLANSKY

538.566.2

1200. Electric waves in moving plasms. W. O. Schumann. *Z. angew. Phys.*, **2**, 393–9 (*Oct.*, 1950) *In German.*

The propagation of electromagnetic waves along moving plasms in dielectric or conductive surroundings is investigated by means of the relativistic transformations. The phase velocity is a function of the frequency for conductive walls whether the plasm is moving longitudinally or is static. If a very strong stationary magnetic field exerts a focusing action in the plasm there are two waves moving in opposite directions. The oscillations of the heavy positive ions have not been considered. W. SUMMER

538.566.2 : 621.392.26

1201. Fabrication of a high power resonant waveguide window. E. V. Edwards and K. Garoff. *Rev. Sci. Instrum.*, **21**, 787–9 (*Sept.*, 1950).

The inability of present waveguide pre-TR and TR-tube windows to withstand high transmitter power necessitates improved window design if 3 000 Mc/s radar systems are to continue using the conventional band-pass TR protective device. The fabrication o glass window with a loaded Q-factor of 4 is describ and operational tests at high-line power are discusse This construction permits the TR tube parts to brazed in a hydrogen furnace and a more rigoro pumping schedule to be followed. A flow chart the window processing operations and pictures of t window and pre-TR tube are included.

538.566.2 : 621.392.26 : 621.317.7

1202. An instrument to demonstrate the synthesis a wave-guide mode of propagation. H. M. Barlo *J. Sci. Instrum.*, **27**, 307–9 (*Nov.*, 1950).

A synthetic waveguide mode of propagation can set up in a skeleton channel of rectangular cros section employing superimposed longitudinal a transverse waves. A convenient and convinci means of demonstrating the transition from T.E. to waveguide modes is thus provided, and a visu picture of the field distribution under different co ditions of operation, including evanescence, is o tained. This is achieved with sufficient accuracy establish experimentally the principles involved.

538.566.3 : 551.510.535 : 621.396.

1203. The Poynting vector in the ionosphere J. C. W. Scott. *Proc. Inst. Radio Engrs*, **38**, 1057– (*Sept.*, 1950).

The equations of motion of ionospheric electrons the field of plane electromagnetic waves subject to t frictional force of collision and to the force of t earth's magnetic field are developed in a form pe mitting graphical calculation of the wave polarizatio The complex Poynting vector is then calculated terms of the polarization, the complex refractive inde and a third function related to the forward tilt of t electric vector. Graphical integration is used obtain curves representing the direction of energy flo for the ordinary and extraordinary modes, in a par bolic distribution of ionization for fixed values geomagnetic latitude, collision frequency and wa frequency for the case of vertical wave propagatio When collision is taken into account, the deflecti has a small westward component for both ordina and extraordinary modes. At zero collision fr quency the deflections are in the vertical plane of t earth's field; the ordinary mode bending towards t poles and the extraordinary mode towards the equato The normal ionization gradient with latitude, togeth with diurnal expansion and contraction of the ioniz region, can explain the diurnal variation in t $f^x - f^0$ critical frequency difference as due to t diurnal variation in the total path deflection.

538.566.3 : 551.594

1204. On the origin of harmonics at points in t ionosphere where the dielectric constant becomes zer K. Försterling and H. O. Wüster. *C.R. Aca Sci., Paris*, **231**, 831–2 (*Oct.* 23, 1950) *In French.*

A brief description of theoretical work giving r details of the calculations. J. M. HOUG

538.566.3 : 551.594.6 : 621.396.

1205. Magneto-ionic triple splitting of ionospher waves. O. E. H. Rydbeck. *J. Appl. Phys.*, 2 1205–14 (*Dec.*, 1950).

The entire phenomenon was examined theoretical and as a result it has been possible to show that stro

coupling often exists between the ordinary and z components as a critical level. It has further been possible to show that the z wave becomes strongly excited when the collisional frequency ν approaches the critical collisional frequency ν_c of Appleton and Builder. When ν is larger than ν_c the o echo rapidly disappears and only the z and x components remain (if ν_c is sufficiently small, i.e. at very high latitudes). A useful expression for the transmission coefficient of the o–z wave has been derived. A.

538.566.3 : 551.594.6 : 621.396.11

1206. Computation of propagation in the ionosphere. J. C. W. Scott. *J. Geophys. Res.*, **55**, 267–70 (*Sept.*, 1950).

By the use of hyperbolic functions of a complex variable, the Appleton–Hartree equations of radio-wave propagation in the ionosphere are put into a simple form suitable for computation. It is shown that the indices of refraction and absorption and the polarization may be easily computed without invoking approximations. A.

538.566.3 : 551.594.6 : 621.396.812.3

1207. Fading of short wireless waves due to the interference between the magneto-ionic components. S. N. Mitra. *Indian J. Phys.*, **24**, 197–206 (*May*, 1950).

It is pointed out that the periodic fading of a single down-coming wave as often observed may be due to this effect when the difference between their equivalent heights of reflection is changing at a uniform rate. A polarized aerial system accepting only one of the components is described, by the use of which, with pulsed transmission, the fading of a single magneto-ionic component can be studied. The effect on fading due to scattering from the ionospheric irregularities, having either a random motion or a steady drift with the existing wind velocity in the ionosphere, is also discussed. Previous experimental evidence shows that when random motion is predominant, the fading is peaky and irregular and that due to a steady drift it is quasi-periodic in nature. In order to get an unambiguous measurement of the motion of the ionospheric irregularities from the fading curves produced at a receiver, and specially at higher wave-frequencies where ionospheric absorption is low, a polarized aerial system is considered essential. A.

538.567 : 535.417

1208. The Michelson interferometer at millimetre wavelengths. W. Culshaw. *Proc. Phys. Soc., Lond. B*, **63**, 939–54 (*Nov.*, 1950).

The required frequency stabilization of the 12·5 mm source is achieved by using a high Q cavity as an r.f. discriminator. Wavelength measurements have been made with various spacings of the interferometer, the measured wavelength increasing as the spacing is reduced. Results indicate that the interferometer gives more accurate measurements of the wavelength when operated well in the Fraunhofer region of diffraction. The operating frequency has been measured using a calibrated frequency meter, and hence the velocity of electromagnetic waves deduced. The value obtained for this velocity agrees, within the accuracy attempted with the present instrument, viz. one part in 10^4, with the generally accepted value for this velocity. The possibilities of increasing the accuracy of its determination with the interferometer are discussed. Measurements of the dielectric constants of low-loss materials by means of the interferometer have been made. Results obtained using ordinary commercial sheets of materials agree within a few per cent with values obtained otherwise. The use of the interferometer as a substandard of length is also discussed. A.

MAGNETIC EFFECTS 538.6

538.632

1209. Note on the Hall potential across an inhomogeneous conductor. J. Volger. Letter in *Phys. Rev.*, **79**, 1023–4 (*Sept.* 15, 1950).

The importance of the actual position of the potential probes in the determination of Hall coefficients in homogeneous conductors is examined by means of potential theory. The results obtained are used to explain possible low values of mobility, as determined from Hall coefficient and conductivity, for materials consisting of highly-conducting grains separated by layers of lower conductivity.

C. A. HOGARTH

538.69

1210. Chemical reactions in a magnetic field. S. Collins and W. A. Bryce. Letter in *J. Chem. Phys.*, **18**, 1297 (*Sept.*, 1950).

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11 : 539.2

1211. Order–disorder for Coulomb forces. J. H. van Santen. *Philips Res. Rep.*, **5**, 282–7 (*Aug.*, 1950).

According to order–disorder theories based on nearest-neighbour interaction, above the critical temperature at which long-range order is destroyed, only a small amount of short-range order is left. From experimental facts (e.g. melting-phenomena and order–disorder phenomena in ferrites) it is concluded that in the case of Coulomb interaction, above the critical temperature a much larger amount of short-range order and a corresponding larger energy of order persists. With the aid of Van der Waerden's low-temperature method it is made plausible that for equal energy differences between the completely ordered and disordered situations, in the case of Coulomb forces long-range order is much more easily destroyed than for nearest-neighbour forces. A.

539.11 : 548.7

1212. A new method for the determination of lattice perturbation due to thermal vibrations. F. Hund and R. Fricke. *Naturwissenschaften*, **37** (*No.* 18) 424–5 (1950) *In German.*

MOLECULAR STRUCTURE 539.13

539.132

1213. The angle-angle interaction in the vibration potential function of pyramidal molecules. L. Burnelle and J. Duchesne. Letter in *J. Chem. Phys.*, **18**, 1300–1 (*Sept.*, 1950).

539.132

1214. New calculation of the H_2 molecule. A. v. Mohrenstein. *Z. Phys.*, **128** (*No.* 3), 395–408 (1950) *In German.*

Contrary to the Heitler–London method exact zeroth order wave functions are introduced as the unperturbed eigenfunctions of 2 H atoms. No interaction between the 2 atoms is allowed by limiting the potential field of each nucleus to the plane of separation of the atoms. The technique yields more states of 2 H atoms at small separation distances; this difference is important for dissociation of excited states of H_2. Deviations from experimental values of the energy minimum and internuclear distance at equilibrium are $< 1\%$ in this zeroth approximation.

J. JACOBS

539.132

1215. *LCAO* self-consistent field calculation of the π-electron energy levels of *cis*- and *trans*-1,3-butadiene. R. G. Parr and R. S. Mulliken. *J. Chem. Phys.*, **18**, 1338–46 (*Oct.*, 1950).

The π-electrons of the molecules *cis*- and *trans*-1,3-butadiene are treated by the method of antisymmetrized products of molecular orbitals, the molecular orbitals being taken as linear combinations of $2p\pi$-Slater atomic orbitals with effective charge 3·18. The best ground state LCAO molecular orbitals obtainable from these are found by application of a method recently proposed by Roothaan which is based on the variational theorem, and the π-electron energy of the ground state is calculated. Including a correction for nuclear repulsions, the *trans*- form is computed to be 0·12 eV more stable than the *cis*-form. Using the ground state orbitals to build up excited state wave functions, the energies of 4 singly excited singlet states and the corresponding triplet states are calculated, there resulting for the average of the lowest singlet and triplet states the excitation energy 5·4 eV for *cis*- and 5·7 eV for *trans*-, the experimental value for the lowest singlet state (probably for *trans*-) being 6·0 eV. The first ionization potential is computed to be 9·7 eV for both *cis*- and *trans*-, whereas the observed value is 9·1 eV. No extra-geometrical empirical data are used except in the calculation of ionization potentials, where the value $-11{\cdot}28$ eV based on atomic spectroscopic data is used for the energy of a $2p\pi$-electron in a C atom in its valence state.

539.132

1216. On the analytical expression of quantities in the theoretical chemistry of some nitrogen derivatives. R. Gouarné. *C.R. Acad. Sci., Paris*, **231**, 856–8 (*Oct.* 23, 1950) *In French.*

These are established for the ground and first excited states, based on molecular orbital theory. The cases considered are $R-(n-1)$ polyenes with n centres, $R-1-R'-p$ polyenes with $n=p+2$ centres; R, R' represent N, NH_2, or heteroatoms. J. JACOBS

539.132

1217. Relation between the Franck–Condon frequencies of absorption and fluorescence for some unsaturated hydrocarbons. S. L. Altmann. *Proc. Phys. Soc., Lond. A*, **63**, 1234–40 (*Nov.*, 1950).

Differences between the Franck–Condon frequencies for emission and absorption are calculated for butadiene, naphthalene and anthracene. The molecular-orbital method is used and its validity in the present case is discussed. A correlation with the experimental data has been attempted for anthracene and appears to be satisfactory. It is shown that the calculated values may be correlated qualitatively with the fluorescence efficiencies of the molecules. A.

539.132

1218. Exchange and other two-centre integrals with 2*s* and 2*p* wave-functions. H. Kopineck. *Z. Naturforsch.*, **5a**, 420–31 (*Aug.*, 1950) *In German.*

Electron interaction integrals necessary for calculation of chemical binding in diatomic molecules are evaluated for 2*p*- and for both hydrogen-like and Slater-type 2*s*-wavefunctions. The overlap, transition and non-exchange Coulomb integrals are given in closed form, whilst the exchange Coulomb integrals and those ionic Coulomb integrals of the type occurring for the N_2-molecule are expressed in terms of two non-standard integrals which have been evaluated numerically as required. The results are also given numerically in a table covering the range of $ZR/2a_0$ of interest. R. H. Dalitz

539.132

1219. General form of the force constant matrix for harmonic vibrations. W. J. Taylor. Letter in *J. Chem. Phys.*, **18**, 1301–2 (*Sept.*, 1950).

The force constant matrix F consistent with an observed set of frequencies (forming a diagonal matrix Λ) is of the form $F = TB\Lambda B'T'$ where T is a matrix characteristic of the system and B any real and orthogonal matrix. By this means a systematic study of force constants is possible. J. R. Maddox

539.132 : 535.375.5 : 541.57

1220. On the calculation of characteristic frequencies of alternating cyclic chains. M. Parodi. *C.R. Acad. Sci., Paris*, **231**, 609–10 (*Sept.* 25, 1950) *In French.*

A regular polygon is treated with alternate masses m and M at the corners. All bond-stretching force constants are equal and only variations of bond lengths are considered. The resulting determinant for the frequencies is solved. J. JACOBS

539.132 : 536.77

1221. Harmonic oscillator contributions to the thermodynamic functions. P. Torkington. *J. Chem. Phys.*, **18**, 1373–9 (*Oct.*, 1950).

Tables giving the harmonic oscillator contributions to the specific heat, internal energy and free energy functions directly, for frequencies in the range 100 to 3 600 cm^{-1}, at 9 standard temperatures, have been drawn up. A.

539.132 : 541.65 : 535.343.2

1222. Results and problems concerning the vibration spectrum of naphthalene. H. Luther. *Abh. Braunschw. Wiss. Gesell.*, **1**, 33–7 (1949) *In German.*

For a discussion of the fundamental vibrations of

aphthalene it is very important to know the spec-
um of naphthalene-d_1 and naphthalene-d_8. These
ubstances have been synthesized and their Raman-
nd infrared-spectra have been measured. It is pre-
umed that the shifts in the region of $\Delta\nu$ 1585 and
625 are due to the system of the double bonds. If
ne substituents are less electronegative, the shifts
625 rise to $\Delta\nu$ 1630–1640, for instance, by paraffinic
nd olefinic substitution. In this case not all C–C
onds probably are equivalent, but the 1, 2-C–C bonds
re more ethylenic. A.

539.133

223. Conjugated compounds. II. Simple potential nergy functions, absorption spectra and ionization in near polyenes. N. S. BAYLISS. *Aust. J. Sci. Res. A*, , 109–27 (*March*, 1950).

539.133

224. Statistical radius of methylenic chains. -F. JOLIET. *C.R. Acad. Sci., Paris*, **231**, 618–19 *Sept.* 25, 1950) *In French.*

The molar volume increment per CH_2 group is 6·3 and 16·5 cc, respectively, for the higher normal araffins and higher cyclanes. The density of the igher cyclanes, containing n CH_2 groups, tends to $4n/(16\cdot5n + \Phi)$, where Φ is the free intermolecular pace and the methylenic groups are thus perfectly eformable and compactly packed. The statistical adius of the CH_2 chains is calculated as 2·56 Å.

W. R. ANGUS

539.133

225. The barrier to internal rotation in methyl-uoroform. H. S. GUTOWSKY AND H. B. LEVINE. etter in *J. Chem. Phys.*, **18**, 1297–8 (*Sept.*, 1950).

539.133

226. Proton magnetic resonance in polyethylene. . NEWMAN. Letter in *J. Chem. Phys.*, **18**, 1303–4 *Sept.*, 1950).

539.133 : 537.531 : 535.434

227. An X-ray investigation of the shapes and ydrations of several protein molecules in solution. I. N. RITLAND, P. KAESBERG AND W. W. BEEMAN. . *Chem. Phys.*, **18**, 1237–42 (*Sept.*, 1950).

The X-ray scattering curves of 5 proteins in solution ave been measured at small angles. The radii of yration of the protein molecules are determined from ne scattering curves. These data together with the nown molecular weights, densities and frictional atios are used to estimate the axial ratios and hydra-ons of the molecules. Some possibilities and limita-ons of the method are pointed out. A.

TOMIC STRUCTURE . NUCLEUS . ISOTOPES
539.15

539.152.1

228. Some nuclear levels. M. F. SOONAWALA. *ndian J. Phys.*, **24**, 315–19 (*July*, 1950).

Considers the nuclear levels of Mg^{24} and Be^8 on the uthor's theory of nuclear structure [see Abstr. 391 948)]. A. O. STANESBY

539.152.1

229. Nuclear magnetic relaxation and resonance line shift in metals. J. KORRINGA. *Physica*, **16**, 601–10 (*July–Aug.*, 1950).

A detailed theory is given of the nuclear relaxation time in metals. The $1/T$ law of Heitler and Teller, which is imposed by the statistics of the electrons, is obtained by using the Bloch approximation of metals. An approximate relation is derived between the relaxation time τ and the relative line shift $\Delta H/H$, viz. $\tau(\Delta H/H)^2 = \hbar)\pi kTg^2$ where g is the nuclear g-factor in Bohr-units. The experimental results on Li^7, Al^{27} and Cu^{63} are discussed with special reference to the influence of the correlation between the electrons. The deviations from the $1/T$ law for Li are all or nearly attributed to the influence of paramagnetic impurities. A.

539.152.1

1230. The binding energy of ^{4}He. A. H. WAPSTRA. *Physica*, **16**, 611–17 (*July–Aug.*, 1950).

The difference in mass between the neutron and the proton, and the binding energies of the deuteron and the α-particle are calculated from various nuclear reaction cycle energy values, and various mass spectrograph doublets are compared with values computed from nuclear reactions. It is shown that the values obtained for the α-particle binding energy lack precision. J. HUGHES

539.152.1

1231. The hydrodynamics of nuclear dipole oscillations. H. STEINWEDEL AND J. H. D. JENSEN. *Z. Naturforsch.*, **5a**, 413–20 (*Aug.*, 1950) *In German.*

Extension of a previous paper [Abstr. 8908 (1950)]. The (γ-ray) nuclear resonance absorption frequency is calculated by applying hydrodynamics to a special nuclear model. The resonance frequency calculated in a first approximation, in which the effect of the Coulomb energy is neglected, is 30% lower than that experimentally observed, but has the correct variation with mass number; higher approximations improve the agreement. The cross-sections for absorption and resonance scattering of γ-rays is discussed. J. HUGHES

539.152.1

1232. Nuclear size resonances. K. W. FORD AND D. BOHM. Letter in *Phys. Rev.*, **79**, 745–6 (*Aug.* 15, 1950).

The bound scattering amplitude, derived from the scattering of slow neutrons by nuclei, shows some evidence of varying regularly as a function of nuclear size and therefore mass number A. There is some evidence for resonances at $A = 8$, 55, 151, for which tentative explanations are put forward on the basis of various nuclear models. J. HUGHES

539.152.1

1233. Nuclear magnetic resonance. C. J. GORTER. *Ned. Tijdschr. Natuurkde.*, **16**, 207–14 (*Sept.*, 1950) *In Dutch.*

A review of recent experimental work.

E. P. WOHLFARTH

539.152.1

1234. On the spins of Li^6 and B^{10}. G. RACAH AND N. ZELDES. Letter in *Phys. Rev.*, **79**, 1012–13 (*Sept.* 15, 1950).

The hypotheses of extreme *jj* coupling with a suitable mixture of exchange forces, suggested by Inglis [Abstr. 6677 (1950)] and by Mayer [Abstr. 6008

(1950)] to reconcile with the shell model the observed difference of spin between Li^6 and B^{10}, are shown not to give the correct spin for B^{10}. An interaction of this kind, able to achieve their aim, is not otherwise satisfactory. R. H. DALITZ

539.152.1

1235. Nuclear dipole vibrations. H. STEINWEDEL, J. H. D. JENSEN AND P. JENSEN. Letter in *Phys. Rev.*, **79**, 1019 (*Sept.* 15, 1950).

Resonances recently observed in (γ, x) processes at γ energies $\sim$ 20 MeV are accounted for quantitatively as classical dipole vibrations of the proton fluid relative to the neutron fluid, the total density remaining constant. Damping by radiation and friction is also evaluated [see also Abstr. 659 (1949); 4262, 6066 (1950)]. W. J. SWIATECKI

539.152.1

1236. Proton density variation in nuclei. H. STEINWEDEL AND M. DANOS. Letter in *Phys. Rev.*, **79**, 1019–20 (*Sept.* 15, 1950).

539.152.1

1237. A new method of integration of weak nuclear magnetic resonance signals. G. SURYAN. Letter in *Phys. Rev.*, **80**, 119 (*Oct.* 1, 1950).

A high signal-to-noise ratio may be attained by using magnetic sound-recording apparatus.

E. P. WOHLFARTH

539.152.1

1238. Shell structure of atomic nuclei. P. F. A. KLINKENBERG. *Ned. Tijdschr. Natuurkde*, **16**, 221–34 (*Oct.*, 1950) *In Dutch.*

Gives a general discussion of the systematic classification of nuclear energy levels. E. P. WOHLFARTH

539.152.1

1239. The density distribution inside nuclei and nuclear shell structure. W. J. SWIATECKI. *Proc. Phys. Soc., Lond. A*, **63**, 1208–18 (*Nov.*, 1950).

A method of evaluating the density distribution of particles inside a heavy nucleus is described. The results are used to show that the electrostatic repulsion between protons is too weak to produce a nucleus sufficiently hollow to explain the observed "closed shells" at $N, Z = 50, 82$. A.

539.152.1

1240. Spin orbit coupling in the nuclear shell model. J. HUGHES AND K. J. LE COUTEUR. *Proc. Phys. Soc., Lond. A*, **63**, 1219–22 (*Nov.*, 1950).

It is shown that the magnitude of the doublet splitting postulated in Mayer's nuclear shell model is consistent with that observed in He^5. The strength of the indicated spin orbital interaction between pairs of nucleons is worked out. A.

539.152.1 : 539.185

1241. On a possible contribution to knowledge of the nuclear field. M. VERDE. *Helv. Phys. Acta*, **23** (*No.* 5) 501–3 (1950) *In German.*

The dispersion formula for one-particle potential scattering is generalized for presence of spin-orbit forces, which affect the position of resonance levels and the corresponding angular distribution. The author suggests neutron and proton scattering by closed shell nuclei (e.g. C^{12}, O^{16}) to determine thus properties of the central nuclear field and the presence of possible spin-orbit forces, as required by Mayer–Jensen nuclear shell structure theory.

R. H. DAL

539.152.1 : 539.1

1242. On spin dependent nuclear "radii." C. MUEHLHAUSE. Letter in *Phys. Rev.*, **79**, 1 (*Sept.* 15, 1950).

539.15

1243. The nuclear magnetic moment of scandium N. F. RAMSEY. Letter in *Phys. Rev.*, **79**, 1 (*Sept.* 15, 1950).

539.15

1244. On the nuclear moments of iridium isotop P. BRIX, H. KOPFERMANN AND W. V. SIEME *Naturwissenschaften*, **37** (*No.* 17) 397–8 (1950) *German.*

The hyperfine structures of Ir 191 and 193 we studied by optical methods and, contrary to the fi ings of B. Ventkatesachar and L. Sibaiya [*Proc. Ind Acad. Sci. A*, **2**, 203 (1935)] nuclear spins of $\frac{3}{2}$ we obtained in both cases. This leads to $d\frac{3}{2}$ grou states for both nuclei in agreement with the sh model of M. Goeppert-Mayer [Abstr. 1911, 6006 (1950)]. W. J. SWIATEC

539.152

1245. Note on the Li^7 quadrupole moment. R. PRESENT. *Phys. Rev.*, **80**, 43–7 (*Oct.* 1, 1950).

Recent measurements unexpectedly determine t sign of the quadrupole moment as positive, althou the magnitude is uncertain. On the quasi-aton model the ground state is $1s^4 2p^3\ ^2P_{\frac{3}{2}}$ and of symmet [3] in Wigner's "first approximation." The cor sponding quadrupole moment is -6 in units $\langle r^2 \rangle_{2p}/25$. The explanation of the discrepancy sought in configuration interaction. A variation calculation of the moment has been made taking in account the P states of symmetry [3] from the lo configurations $1s^4 2p^2 3p$ and $1s^4 2p^2 4f$. The maximu value of the moment is $+2{\cdot}32$ in the above uni this value is increased by including other configur tions. The admixture of [3] P states from excite configurations has no effect on the magnetic mome nor on the matrix element for Be^7 K-capture into t ground state of Li^7; this is satisfactory since t quasi-atomic model agrees reasonably well wi experiment in these instances. When the [3] D stat from the above configurations are included in t variational calculation, the maximum is raised to $8{\cdot}0$ The configuration interaction need not be large in th case to produce a positive moment; however, t inclusion of the [3] D states does impair the agreeme with the magnetic moment and the K-capture dat Considering the wide margin of uncertainty in t estimated experimental quadrupole moment, we fin that all the data are adequately explained witho assuming large spin-orbit interaction or larg departures from partition symmetry.

539.152

1246. Nuclear magnetic resonance for K^{39}. T. L COLLINS. Letter in *Phys. Rev.*, **80**, 103 (*Oct.* 1, 1950

539.152.2 : 539.15

1247. Accurate determinations of nuclear momen and atomic constants. J. KORRINGA. *Ned. Tijdsch Natuurkde*, **16**, 215–20 (*Sept.*, 1950) *In Dutch.*

A review describing experimental methods for th

etermination of the magnetic moments of the proton nd electron, and discussing the accuracy of the values iat have been obtained. E. P. WOHLFARTH

539.153

248. Multiplet separation factors and Γ-sum rule. . SENGUPTA. *Indian J. Phys.*, **24,** 185–8 (*May*, 1950). Weak field Γ-sum rule has been used to give a eneral proof of the inversion of X-ray doublets and o calculate the multiplet separation factors in a mple way. A.

539.153

249. Isomers and shell structure. P. AXEL. Letter n *Phys. Rev.*, **80,** 104–5 (*Oct.* 1, 1950).

539.153

250. The di-iso-electronic row and the effective harge in the *L* isorows. A. F. RICHTER. *Phil. Mag.*, **41,** 983–7 (*Oct.*, 1950).

See Abstr. 2864 (1948). The author's equation for he di-iso-electronic row enables the electron affinity f H, $E_H = 0{\cdot}74$ eV, to be computed by extrapola- on. The author's equation is nearly identical with iat of Hylleraas, but differs in an important term rom that of Eucken. A relation is given between creening number and effective charge on one hand, nd nuclear charge number Z and number of electrons n the isorow, i, on the other. Numerical values of he constants required to calculate screening numbers $_i$ in the K, L, and $M - s$ isorows are given. A.

539.153 : 535.338.1

251. Estimation of ionization potentials by com- arison with neighboring elements. H. N. RUSSELL. . *Opt. Soc. Amer.*, **40,** 618–19 (*Sept.*, 1950).

If a spectrum contains an unperturbed series of at east 3 members, the ionization potential can be ound with fair accuracy from its limit. If but 2 iembers are available, serious errors occur if the Ritz orrection is ignored. This correction can often be osely estimated by comparison with elements of eighbouring atomic numbers. This method is miliar, but published estimates have not been made n a uniform system. Such estimates for spark pectra from Ca II to Zn II give ionization potentials iffering from a smooth formula by $\pm 0{\cdot}02$ V, while he differences in the 3 cases where the Ritz correction as not applied, average $\pm 0{\cdot}39$ V. A.

539.153 : 537.561

252. Probability of auto-ionization in light atoms. .-Y. WU AND L. OUROM. *Canad. J. Res. A*, **28,** 42–8 (*Sept.*, 1950).

With a view to testing the adequacy of the per- rbation theory as applied to radiationless transitions light atoms, the probability of such a transition in he Be atom from the $1s^22p3s\ ^3P$ state to the con- nuum $1s^22s$ + ejected p electron has been calculated. he wave functions employed for the discrete states re obtained by the variational method and the wave nction for the continuous state by numerical tegration of the Schrödinger equation. The ansition probability obtained is 5×10^{13} per sec, ading to a width of ~ 290 cm^{-1} for the level $^2p3s\ ^3P$. This is at least 10^3 times larger than hat is indicated by the observed widths of the spectral nes. Thus the present calculation, together with milar earlier calculations for the He atom, shows that the perturbation theory is inadequate for the light atoms. It is also pointed out that there is an inconsistency in the use of the perturbation theory in these calculations and those on the Auger effect in the literature since the use of variational or "screened" wave functions implies that a part of the electron–electron interaction has already been included in the initial approximation, and it is hence incorrect to treat this whole interaction as the perturbation causing the transition. A.

539.153 : 539.133.535.33

1253. The influence of magnetic and electrical properties of atomic nuclei on the energy levels of atoms and molecules. H. B. G. CASIMIR. *Ned. Tijdschr. Natuurkde*, **16,** 198–206 (*Sept.*, 1950) *In Dutch.*

A review discussing the theoretical treatment of the hyperfine structure of spectral lines. Consideration is given to the isotope effect, the influence of magnetic dipole and electrical quadrupole moments on atomic spectra, and the effect of the latter on molecular rotational spectra. E. P. WOHLFARTH

539.153.1 : 541.132

1254. Correlation of ionic and atomic radii with the heat of hydration. W. D. ROBERTSON. *J. Chem. Phys.*, **18,** 1365–6 (*Oct.*, 1950).

It is shown that Pauling's ionic and atomic radii may be correlated with the ionic heat of hydration in a manner which provides a method of intercomparison of the different radii and demonstrates their self-consistency. The correlation also indicates significant differences between ionic and atomic radii which may be interpreted in terms of the ion-dipole interaction theory of solutions. A.

539.153.4 : 539.181

1255. On the hyperfine structure of hydrogen and deuterium. A. G. PRODELL AND P. KUSCH. Letter in *Phys. Rev.*, **79,** 1009–10 (*Sept.* 15, 1950).

539.154

1256. Apparent error in the measured mass of S^{32}. A. S. PENFOLD. Letter in *Phys. Rev.*, **80,** 116–17 (*Oct.* 1, 1950).

539.155.2

1257. The isotope abundances of boron. Mass spectrometric analysis of the electron collision products of BF_3 and BCl_3. O. OSBERGHAUS. *Z. Phys.*, **128** (*No.* 3) 366–77 (1950) *In German.*

The relative abundance measured is $B^{11}/B^{10} = 4{\cdot}11 \pm 0{\cdot}2$. No deviations of the abundance for samples of different origin have been found within the limits of accuracy. The appearance potentials of the various ions derived from BF_3 and BCl_3 have been measured and their relation with thermochemical data is discussed. A marked difference between the ionization functions of BF_3 and BCl_3 has been found. H. LONDON

539.155.2

1258. Isotopic constitution of thulium. C. R. LAGERGREN AND M. E. KETTNER. Letter in *Phys. Rev.*, **80,** 102 (*Oct.* 1, 1950).

539.155.2 : 551.510.4

1259. Isotopic separation due to settling in the atmosphere. J. H. MCQUEEN. Letter in *Phys. Rev.*, **80,** 100–1 (*Oct.* 1, 1950).

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16 : 614.898

1260. A system for the collection and purification of radon by remote control. C. H. SHIFLETT, M. E. STEIDLITZ AND W. DAVIS, JR. *Rev. Sci. Instrum.*, **21**, 842–4 (*Oct.*, 1950).

A plant for the collection and purification of radon has been constructed. In order to reduce the gamma-radiation level, the plant was designed to be operated entirely by remote control except for the final sealing of the radon capsule. This plant compares favourably with other collection systems both with regard to the time required for a collection and to the yield of radon obtained. A.

539.16.08

1261. A precision method of counting radioactive liquid samples. A. J. FREEDMAN AND D. N. HUME. *Science*, **112**, 461–3 (*Oct.* 20, 1950).

Variations due to self-scattering and self-absorption in the relative counting of solid non-carrier-free activity were much reduced (to $< 1\%$) by counting the activity in liquid form, covered by a lacquer film. Difficulties at first arose with the G.M. tubes, but a satisfactory arrangement was evolved.

A. O. STANESBY

539.16.08 : 539.165

1262. A calorimetric measurement of the disintegration rate of a P^{32} source. J. G. BAYLY. *Canad J. Res. A*, **28**, 520–9 (*Sept.*, 1950).

The calorimetric method of measuring sources is of value when the average energy per disintegration is known, and may be used to check the accuracy of an "absolute" beta counting technique. This paper describes a differential calorimeter designed for this type of measurement, and an experimental determination of the disintegration rate of a P^{32} source. The calorimetric measurement gave a value of the disintegration rate with a probable error of 0·7% differing by 1·8% from the result obtained from an absolute count of the β-activity. The absolute count was accurate to $\pm 2\%$. The calorimeter has a sensitivity limit of less than 10 μW, and makes use of thermistors to measure temperature changes of the order of 10^{-3} °C. A.

539.16.08 : 539.165

1263. Distribution of absorbed energy around a point source of β radiation. R. LOEVINGER. *Science*, **112**, 530–1 (*Nov.* 3, 1950).

539.16.08 : 778.3 : 551.594.14

1264. Radioactivity induced from the atmospheric air, investigated with the photographic emulsion method. R. SIKSNA. *Ark. Geofys.*, **1**, *Paper* 6, 123–47 (1950).

Radioactive ions were collected by means of a metal electrode charged negatively to 4·5 kV and suspended in the room under investigation. The activity of this electrode was then measured by pressing it into contact with the surface of an Ilford Nuclear Research emulsion type E1. Alternatively, a paper sheath was fitted over the inner electrode of an Ebert aspirator, and after activation, was pressed between two emulsion layers. The activation determined in this way consisted of α-particle emitters; the ranges of the α-particles were measured and fitted in well with the various groups to be expected from the presence of radium and thorium. Different roc in the building investigated differed widely in quantity and quality of the radioactive contaminati W. F. BI

539.163 : 539.

1265. On the branching of AcA and the long ra radiation from actinium active deposit. P. AVIGN *J. Phys. Radium*, **11**, 521–3 (*Aug.–Sept.*, 1950) *French.*

The growth of an α-particle group from RaAc range 7·40 ± 0·02 cm, and intensity 2·3 ± 0·2 × 1 per disintegration of AcA is ascribed to the gro of At^{215} by the β-branching of AcA. An α-group range 9·1 ± 0·1 cm, of intensity 0·9 ± 0·1 × 1 per disintegration of AcC′ was also observed. Th results confirm earlier work. B. R

539.16

1266. A precision determination of the half-life radium C′. G. VON DARDEL. *Ark. Fys.*, **2**, *Paper* 337–52 (1950).

A 20-channel time analyser has been used measure the time distribution of α-pulses from proportional counter, which contains a small rad capillary, relative to a preceding β-pulse from a of G.M.-counters surrounding the α-counter. T value obtained for the half-life is 163·7 ± 0·2 μs the standard error being that due to the statisti fluctuations of the experimental points, increased b factor of $\sqrt{2}$ in order to take account of possi unknown sources of accidental or systematic err The value is not inconsistent with previous valu obtained with the method of delayed coincidenc but seems outside the experimental errors of valu obtained with the method of variable resolutio It is suggested that systematic errors may be pres in values obtained by this latter method.

539.163

1267. The short-lived metastable state of Hg^{19} studied by delayed coincidences. K. P. MEYE E. BALDINGER AND P. HUBER. *Helv. Phys. Acta*, (*No.* 5) 517–21 (1950) *In German.*

A fast coincidence circuit of resolving ti 4×10^{-9} sec [Abstr. 4167 (1950)] was used in co junction with electron multiplier tubes and anthrace screens to study the β–γ coincidence rate for Au as a function of relative delay between the β- a γ-rays. Both instantaneous and delayed coincide γ-rays were observed, the half-life for the latt (which were also the softer γ-rays) being $3 \cdot 5 \times 10^{-8}$ s Their relative intensities were consistent with simple cascade process in Hg^{198}, and prelimina results indicate that all γ–γ coincidences have relati delays consistent with the formation of a metastab state of half-life $3 \cdot 5 \times 10^{-8}$ sec. These results expla the discrepancy between the findings of MacInty [Abstr. 7223 (1949)] and of Bell and Petch [Abst 3347 (1950)]. The former could not resolve t instantaneous from the delayed coincidences, where the latter detected undelayed events preferentially.

A. P. FRENC

539.163

1268. Cross-over transitions in Ir^{194}, Ag^{110}, Cs^{13} R. WILSON. Letter in *Phys. Rev.*, **79**, 1004 (*Sept.* 1 1950).

539.163.2

1269. Disintegration scheme of scandium^{46}. B. N. SORENSEN, B. M. DALE AND J. D. KURBATOV. Letter in *Phys. Rev.*, **79**, 1007 (*Sept.* 15, 1950).

539.163.2

1270. Electron capture/beta-decay ratio in K^{40}. T. GRÁF. Letter in *Phys. Rev.*, **79**, 1014 (*Sept.* 15, 1950).

539.163.2

1271. A note on 11·5-day Tl^{202}. G. WILKINSON. Letter in *Phys. Rev.*, **79**, 1014–15 (*Sept.* 15, 1950).

539.163.2

1272. Decay of Hg^{197}. H. FRAUENFELDER, O. HUBER, A. DE-SHALIT AND W. ZÜNTI. Letter in *Phys. Rev.*, **79**, 1029–30 (*Sept.* 15, 1950).

539.163.2

1273. Radioactivity of Ni^{59} and Ni^{63}. H. W. WILSON. Letter in *Phys. Rev.*, **79**, 1032–3 (*Sept.* 15, 1950).

Pure nickel oxide was irradiated with thermal neutrons for 2 months, purified from any active Co contamination and examined in a proportional counter. The counts obtained were largely due to Ni^{63}, but a small background remained after covering the source, and was shown to contain a peak corresponding to the $K\alpha$ X-ray of Co, and presumably due to the decay of Ni^{59} by K-capture, with a $\frac{1}{2}$-life of $\sim 8\times10^5$ yrs if the absorption cross-section of Ni^{58} for slow neutrons is taken as $\sim 4\cdot4$ barns. The $\frac{1}{2}$-life of Ni^{63} is estimated as $2\cdot1$ yrs. A. O. STANESBY

539.163.2

1274. Measurement of absolute electron capture rates with an application to the decay of Ni^{57}. G. FRIEDLANDER, M. L. PERLMAN, D. ALBURGER AND A. W. SUNYAR. *Phys. Rev.*, **80**, 30–3 (*Oct.* 1, 1950).

Observation of radiations from 36-hr Ni^{57} with a proportional counter and pulse-height analyser shows that Co X-rays are emitted. Decay is divided equally between K-capture and emission of 845-keV positrons. The positron spectrum has the allowed shape. Coincidence measurements involving the comparison of Ni^{57} and Na^{22} give the result that both K-capture and positron emission in Ni^{57} are followed by emission of a 1·9-MeV gamma-quantum. In the K branch there are some 120-keV gamma-rays and possibly others of energy less than 0·5 MeV in cascade with the hard gammas. A.

539.163.2

1275. Os^{182} and Os^{183}, new radioactive osmium isotopes. B. J. STOVER. Letter in *Phys. Rev.*, **80**, 99 (*Oct.* 1, 1950).

539.163.2

1276. On the isomerism of Xe^{131}. I. BERGSTRÖM. Letter in *Phys. Rev.*, **80**, 114 (*Oct.* 1, 1950).

539.163.2

1277. Neutron binding energies. J. R. HUIZENGA, A. B. MAGNUSSON, O. C. SIMPSON AND G. H. WINSLOW. Letter in *Phys. Rev.*, **79**, 908 (*Sept.* 1, 1950).

It is shown that the neutron binding energies of certain Pb and Bi isotopes, derived from (d, p), (d, t), (γ, n) and (n, γ) reaction energies, enable unambiguous energy differences between the $4n$, $4n + 3$, and $4n + 2$ radioactive series to be obtained. J. HUGHES

539.163.2 : 539.172.3

1278. Radioactivities of Nb^{99}, Ta^{185}, and W^{185}, and the relative (γ,n) and (γ,p) cross sections of Mo^{100}. R. B. DUFFIELD, L. HSIAO AND E. N. SLOTH. Letter in *Phys. Rev.*, **79**, 1011 (*Sept.* 15, 1950).

539.164.2

1279. Theory of natural alpha-radioactivity. B. L. COHEN. Letter in *Phys. Rev.*, **80**, 105–6 (*Oct.* 1, 1950).

539.165

1280. Electron spectrum of Pa^{233}. H. B. KELLER AND J. M. CORK. Letter in *Phys. Rev.*, **79**, 1030–1 (*Sept.* 15, 1950).

The electron spectrum of Pa^{233} ($\frac{1}{2}$-life 27·4 days: obtained from $Th^{232} \xrightarrow{n} Th^{233} \xrightarrow[23\,min]{\beta-} Pa^{233}$) was examined in a permanent magnet photographic β-spectrometer, recording on 25 μ nuclear emulsions. 46 conversion lines and 3 Auger lines were found and a level scheme for U^{233} (the daughter nucleus) is suggested. A. O. STANESBY

539.165

1281. The radiation from Co^{60}. M. DUQUESNE, G. KAYAS AND G.-A. RENARD. *C.R. Acad. Sci., Paris*, **231**, 693–5 (*Oct.* 9, 1950) *In French.*

From measurements of the absorption in Al, a soft β-component of energy ~ 50 keV is reported, of intensity $\sim 30\%$ of the principal β-spectrum. Similar results are claimed from coincidence absorption data, and from measurements made with a magnetic analyser. B. ROSE

539.165

1282. The β-spectrum of C^{14}. S. D. WARSHAW. Letter in *Phys. Rev.*, **80**, 111–12 (*Oct.* 1, 1950).

539.165

1283. Statistical study of β-emitting isotopes. C. MARTIN. *C.R. Acad. Sci., Paris*, **231**, 843–5 (*Oct.* 23, 1950) *In French.*

The distribution curve of the number of beta-emitters against $\log_{10}T$ ($T = \frac{1}{2}$-life) is plotted for 612 isotopes: the curve has a max. at $T \sim 1\cdot5$ hr, but is not symmetrical, having an excess of long-lived isotopes. Similar curves are shown for the various classes of beta-emitters (β^-, β^+, K-capture, internal conversion). A. O. STANESBY

539.165

1284. Forbidden β-decay in ^{24}Na. P. J. GRANT. Letter in *Proc. Phys. Soc. Lond. A*, **63**, 1298–9 (*Nov.*, 1950).

539.165

1285. Multiple scattering of the particles producing the "positive tracks" appearing near beta-ray emitters. G. GROETZINGER AND F. L. RIBE. Letter in *Phys. Rev.*, **79**, 904–5 (*Sept.* 1, 1950).

Twenty positive tracks appearing to have emerged from a P^{32} source in an A–He-filled cloud chamber under 340 gauss magnetic field have been compared with 104 electron tracks from the same source. The angle of deflection between successive 1 cm chords on tracks of similar lengths have been measured and an r.m.s. angle of scattering derived. A curve of this quantity against $H\rho$ has been plotted for the electron tracks. It is suggested that the individual points for the positive tracks fall significantly off the curve and would correspond better to the behaviour

of a particle of twice the electron mass. The probability that tracks of strong positive curvature could occur in the magnetic field as a result of multiple scattering is considered negligible. L. R. SHEPHERD

539.165

1286. New evidence for the existence of positively charged particles appearing near beta-ray emitters. G. GROETZINGER AND D. KAHN. Letter in *Phys. Rev.*, **80**, 108–9 (*Oct.* 1, 1950).

539.165.08

1287. An absolute method for measuring the activity of radioactive isotopes. J. P. KEENE. Letter in *Nature, Lond.*, **166**, 601–2 (*Oct.* 7, 1950).

Under suitable conditions the beta particles from a radio isotope can be measured as a current (1 millicurie producing $3{\cdot}7\times10^{7}$ particles per sec, equivalent to $5{\cdot}93\times10^{-12}$ amp). P^{32} on a thin Al foil is surrounded by a wire grid and placed in an evacuated metal case, the current being measured by an electrometer valve. The effects of secondary emission and gas ionization can be demonstrated and allowed for. The method should be capable of an accuracy of $\pm$ 2%. L. E. MUSSELL

539.166

1288. Gamma-rays of Ag^{105} and Ag^{106}. J. Y. MEI, C. M. HUDDLESTON AND A. C. G. MITCHELL. Letter in *Phys. Rev.*, **79**, 1010 (*Sept.* 15, 1950).

539.166

1289. Gamma-spectrum of Ta^{182}. F. E. O'MEARA. Letter in *Phys. Rev.*, **79**, 1032 (*Sept.* 15, 1950).

539.166

1290. The penetration and diffusion of Co^{60} gamma-rays in water using spherical geometry. G. R. WHITE. *Phys. Rev.*, **80**, 154–6 (*Oct.* 15, 1950).

Ionization and G.M. counter measurements of Co^{60} gamma-rays were made in effectively spherical geometry up to a distance of 252·8 cm (16 mean free paths of the primary radiation) corresponding to an exponential attenuation of the primary radiation by a factor of $8{\cdot}8\times10^{6}$. The "build-up factor" was observed to climb up to 33·8 and approached closely the theoretically predicted trend of asymptotic variation $r^{1\cdot4}$. Preliminary information on the spectral distribution of the radiation is included. A.

539.166.08

1291. A scintillation spectrometer for high-energy gamma-rays. S. A. E. JOHANSSON. Letter in *Nature, Lond.*, **166**, 794–5 (*Nov.* 4, 1950).

539.166.2

1292. Gamma-ray studies using deuterium-loaded photographic plates. C. H. MILLAR, A. G. W. CAMERON AND M. GLICKSMAN. *Canad. J. Res. A*, **28**, 475–87 (*Sept.*, 1950).

Deuterium-loaded nuclear emulsions have been used to study the γ-rays of neutron capture in Na, Cl, and Cd, and the γ-rays following the β-decay of N^{16}. Proton tracks caused by the photodisintegration of D were measured, and from these the γ-ray energies were calculated. Several lines have been observed in the γ-ray spectra of neutron capture. The known energy of the 6·124 MeV γ-ray following the decay of N^{16} (produced in the cooling water of the Chalk River pile) was used to calibrate the plates. A higher energy γ-ray from the decay of N^{16} was tentatively identified as corresponding to a transition from the 6·897 MeV excited level of O^{16} to the ground state and was found to have one-seventh the intensity of the 6·124 MeV γ-ray.

539.166.7

1293. The hard components of scattered gamma-rays. P. B. MOON. *Proc. Phys. Soc. Lond. A*, **63**, 1189–9 (*Nov.*, 1950).

A summary is given of theoretical information on the 3 processes by which gamma-rays can be elastically scattered by atoms, viz. Rayleigh scattering by bound electrons, Thomson scattering by the nuclear charge and (exceptionally) nuclear resonant scattering. Interference between the three scattered waves is considered and shown to be of practical importance as between Rayleigh and Thomson scattering of hard gamma-rays at large angles. Graphs are plotted illustrating the dominance of Rayleigh scattering at very small angles for all energies, and the comparable intensities of Rayleigh and Thomson scattering at high energies and large angles. The unidentified hard component found by Pollard and Alburger in the large-angle scattering of 2·8-MeV gamma-rays by various elements is interpreted as a mixture of Rayleigh and Thomson scattering. Experiments on the scattering of 0·41-MeV gamma-rays at about 115° are reported. In agreement with theory, about 2% of the radiation scattered from Pb is found to retain the full energy; for Cu and Al, the proportion of elastically scattered photons is much smaller. A

539.166.7

1294. The Rayleigh scattering of 0·41 MeV gamma-rays at various angles. A. STORRUSTE. *Proc. Phys. Soc. Lond. A*, **63**, 1197–201 (*Nov.*, 1950).

A report is given on some measurements of the Rayleigh cross-section for scattering of 0·41 MeV gamma-rays by Pb, Cu and Al. At small angles the Rayleigh cross-section in Pb is found to decrease rapidly with increasing angle of scattering from approximately 12 times the Compton cross-section at 3° to a value equal to the Compton cross-section at 12°. In Cu the Rayleigh cross-section is found to equal the Compton cross-section at 4·5°. In Al no substantial excess scattering above the Compton cross-section is found, the smallest angle at which measurements were taken being 3°. At 60°, 90°, 120° and 150° the hard component of the scattered radiation from Pb is found to be respectively 1·77, 1·14, 0·88 and 0·66% of the Compton component as calculated by the Klein–Nishina formula. A

539.166.83

1295. Distribution of recoil nucleus in pair production by photons. R. JOST, J. M. LUTTINGER AND M. SLOTNICK. *Phys. Rev.*, **80**, 189–96 (*Oct.* 15, 1950).

The angular and momentum distribution of the recoil nucleus in pair production by a photon is calculated covariantly by a method which utilizes the unitarity of the S matrix. The results are in disagreement with a recent experiment [Abstr. 4117 (1950)], particularly for small angles and high momentum transfers. The exact total cross-section for pair creation is also given. A

539.166.835

1296. Multiple processes in the production of pairs of electrons by γ-radiation. J. E. Hooper and D. T. King. *Phil. Mag.*, **41**, 1194–6 (*Nov.*, 1950).

Two nuclear photographs have been obtained in which γ-rays, of ~220 and ~2 000 MeV resp. (arising in the decay of π^0-particles at 68 000 ft) appear to produce two pairs of electrons simultaneously (the first is shown in a plate).

A. O. STANESBY

539.166.835

1297. The effect of screening of [on] the cross section for pair production by electrons. D. G. Ravenhall. Letter in *Proc. Phys. Soc., Lond. A*, **63**, 1177 (*Oct.*, 1950).

The effect for electron-nucleus collisions is examined (*a*) by treating the pair production, including screening, by the equivalent photon distribution of the incident electron; (*b*) by treating the pair production in the field of the electron of the equivalent photon distribution of the screened nuclear field. The range (in nuclear research emulsions) for the production of pairs by fast electrons is estimated at 99 cm and 42 cm respectively at 10^9 eV and 10^{10} eV.

J. G. WILSON

539.166.835

1298. Higher approximations to the Klein-Nishina formula from radiation theory. II. M. R. Schafroth. *Helv. Phys. Acta*, **23** (*No.* 5) 542–6 (1950) *In German.*

As shown in Part I [Abstr. 476 (1950)], the e^6 correction $d\sigma_6$ for the differential cross-section of the Compton-effect can be evaluated. This was done in I for the non-relativistic, here for the extreme relativistic case. The approximations impose the condition $\pi - \theta_0 > \theta > \theta_0$, where $\theta_0 \gg m^2/v^2$; so that the total effective cross-section is not determined. The scattering processes not embraced by this formula are least interesting with respect to angular distribution The differential cross-section becomes $d\sigma = d\sigma_4 + d\sigma_6'(\omega) + d\sigma_6''$, where $d\sigma_4$ is the Klein–Nishina formula. The term $d\sigma_6''$ is of the order of 10% of $d\sigma_4$ and varies similarly with θ. Only highly sensitive experiments could verify these corrections.

J. JACOBS

NUCLEAR REACTIONS 539.17

539.172 : 537.591.8

Nuclear transmutations produced by cosmic particles of great energy. *See Abstr.* 598

539.172 : 539.18

1299. On the mechanism of the absorption of nuclear mesons in the nuclei. P. Cüer. *C.R. Acad. Sci., Paris*, **231**, 846–8 (*Oct.* 23, 1950) *In French.*

Various theories of the process [Abstr. 6729 (1950)] are reviewed and a study of the correlation between incident energy and number of branches in photographic stars is reported.

W. J. SWIATECKI

539.172 : 539.18 : 539.166

1300. The γ-ray spectrum resulting from capture of negative π-mesons in hydrogen. W. K. H. Panofsky, L. Aamodt, J. Hadley and R. Phillips. Letter in *Phys. Rev.*, **80**, 94 (*Oct.* 1, 1950).

539.172.13

1301. Angular correlation in the reaction $F^{19}(p, \alpha)O^{16*}(\gamma)O^{16}$. W. R. Arnold. *Phys. Rev.*, **80**, 34–9 (*Oct.*, 1 1950).

The angular correlation of alpha-particles and gamma-rays from the 340 keV resonance in the reaction $F^{19}(p, \alpha)O^{16*}(\gamma)O^{16}$ has been observed. This correlation is very strong and allows a unique identification with a correlation calculated for this transition by the method of Hamilton. If we assume even parity and zero spin for the ground state of O^{16}, even parity and spin ½ for the ground state of F^{19}, this experiment allows the following assignments of spin and parity: 13·24 MeV excited state of Ne^{20}, spin 1, even parity; 6·14 MeV excited state of O^{16}, spin 3, odd parity. Since no pairs have been observed from this resonance reaction, we can also assign even parity to the 6·0 MeV pair-producing state of O^{16}. A.

539.172.13

1302. γ-radiation from the resonant capture of protons by ^{7}Li nuclei. S. Devons and G. R. Lindsey. *Proc. Phys. Soc., Lond. A*, **63**, 1202–7 (*Nov.*, 1950).

Further measurements have been made of the angular distribution of the γ-radiation in the reaction $Li^7(p, \gamma)Be^8$. The results indicate approximate isotropy, at resonance, for both spectral components (17·6 and 14·8 MeV) of the radiations. The difficulties in reconciling the properties of the γ-radiation with results of recent experiments on the scattering of protons by Li are discussed. A.

539.172.13

1303. The long-range protons from the disintegration of carbon by deuterons and a study of the competing reactions. G. C. Phillips. *Phys. Rev.*, **80**, 164–70 (*Oct.* 15, 1950).

The excitation curves for the reaction $C^{12}(d, p)C^{13}$ have been determined at the 3 laboratory angles of 0°, 90° and 150° for the range of deuteron energies 0·78 to 1·55 MeV. Resonances were observed at 0·91, 1·16, 1·30 and 1·435 MeV, corresponding to resonances found previously for the competing $C^{12}(d, p)^*C^{13}$ and $C^{12}(d, n)N^{13}$. In addition, a resonance was observed for the long-range proton group at 1·13 MeV. The angular distributions of the long-range proton group have been determined for 8 energies of bombardment and have been converted to centre-of-mass co-ordinates. These angular distributions have been analysed in terms of the Legendre polynomials and show no terms higher than the 4th order to within the experimental error of about 3%. The intensities, positions, widths and angular distributions of the resonances are discussed. The excitation curves show the effects of large amounts of interference between states. The 1·30 MeV resonance is exhibited at 0° as an "anti-resonance," while the 1·435 MeV resonance shows a shift of maximum yield of about 10 keV for the excitation curves at 0° and 150°. A.

539.172.13 : 539.166

1304. Gamma-ray resonances produced by the bombardment of phosphorus with protons. G. R. Grove, J. N. Cooper and J. C. Harris. Letter in *Phys. Rev.*, **80**, 107–8 (*Oct.* 1, 1950).

539.172.3

1305. The photo-disintegration of oxygen into four alpha-particles. F. K. Goward and J. J. Wilkins. Letter in *Proc. Phys. Soc., Lond. A*, **63**, 1171–2 (*Oct.*, 1950).

Ilford E1 emulsions were irradiated with 23 and 25 MeV bremsstrahlung and about 100 stars were identified as $O^{16} \rightarrow 4He^4$ and selected for detailed analysis by measurement of apparent momentum unbalance. From histograms of calculated Q values for any intermediate Be nucleus, 50–55% of the stars are attributed to $O^{16} + h\nu \rightarrow C^{12*} + 4He^4$, $C^{12*} \rightarrow Be^8 + He^4$, via the C^{12} 9·7 MeV level and the Be^8 ground level. T. G. PICKAVANCE

539.172.3

1306. Ground state ^{8}Be nuclei in photo-disintegration stars. J. J. Wilkins and F. K. Goward. Letter in *Proc. Phys. Soc., Lond. A*, **63**, 1173–4 (*Oct.*, 1950).

The tracks of alpha-particles from ground-state Be^8 fragments, which often occur in photo-disintegrations of C^{12} and O^{16}, appear as distinctive V's, examples of which are shown, and not as single thick tracks as is often supposed. There are difficulties of identification, however, for example when one track of the V is vertically below the other in the emulsion. A star showing the characteristic V, obtained in a B-loaded plate, is presented as evidence for the reaction $B^{11} \rightarrow H^3 + Be^8$. T. G. PICKAVANCE

539.172.3

1307. The cross section for photo-disintegration of the deuteron at low energies. G. R. Bishop, C. H. Collie, H. Halban, A. Hedgran, K. Siegbahn, S. du Toit and R. Wilson. *Phys. Rev.*, **80**, 211–22 (*Oct.* 15, 1950).

Precision measurements have been made of the photo-disintegration of the deuteron with the gamma-rays of Ga^{72} and Na^{24}. Relative cross-sections have been measured at 2·51, 2·62 and 2·76 MeV. Calibration of the sources gave absolute cross-sections at 2·62 and 2·76 MeV. A.

539.172.3

1308. The reaction ^{7}Li(γp)^{6}He. E. W. Titterton. Letter in *Proc. Phys. Soc., Lond. A*, **63**, 1297–8 (*Nov.*, 1950).

539.172.4

1309. The energy Q_{np} of the process $N^{14}(n, p)C^{14}$. P. Meyer. *Z. Phys.*, **128** (*No.* 3) 451–4 (1950) *In German.*

Pure N (obtained by heating sodium azide) was irradiated with thermal neutrons in a proportional ionization chamber (length 20 cm, dia. 4 cm; anode dia. 0·5 mm, working voltage 7 500 V to obtain saturation; gas pressure not given) and the pulses analysed. The value obtained for Qnp was 0·610 ± 0·010 MeV. A. O. STANESBY

539.172.4

1310. Capture cross sections for fast neutrons. R. L. Henkel and H. H. Barschall. *Phys. Rev.*, **80**, 145–9 (*Oct.* 15, 1950).

The fast neutron capture cross-section of Al^{27} was measured by observing the 2·3-minute activity of Al^{28} for neutron energies between 10 and 550 keV. Resonances were observed which showed some correlation with scattering resonances so that radiation widths of some of the levels could be estimated. Measurements of activation cross-sections were also carried out for F, V, Cu^{65}, Ag, I, In^{115} and Au. A.

539.172.4

1311. The production of high energy deuterons by energetic nucleons bombarding nuclei. J. Heidmann. *Phys. Rev.*, **80**, 171–6 (*Oct.* 15, 1950).

A calculation is given of the cross-section for production of fast deuterons ($\gtrsim$ 50 MeV) by fast nucleons ($\gtrsim$ 100 MeV) bombarding heavy nuclei. A corrected Fermi model is used. The dependence on energy is given and also the momentum wave function of a nucleon in a heavy nucleus. A.

539.172.4

1312. Energy distribution of fission fragments from Pu^{239}. D. C. Brunton and W. B. Thompson. *Canad. J. Res. A*, **28**, 498–508 (*Sept.*, 1950).

The measurement of the energy distribution of fission fragments has been extended to include fragments from fission in Pu^{239}. The same equipment was used as in previous experiments on U^{235} and U^{233}. The experimental results parallel very closely those obtained in the previous work. The values obtained for the most probable energies for the light and heavy fragments from Pu^{239} are 94·6 and 65·2 MeV respectively. The statistical accuracy of the data is, as before, an improvement over earlier work in this field, and a more detailed comparison of the three materials is made possible. A.

539.172.4

1313. Total charges of fission fragments in gaseous and solid media. N. O. Lassen. Letter in *Phys. Rev.* **79**, 1016–17 (*Sept.* 15, 1950).

539.172.4

1314. The emission of long-range charged particles in the slow neutron fission of heavy nuclei. K. W. Allen and J. T. Dewan. *Phys. Rev.*, **80**, 181–8 (*Oct.* 15, 1950).

Light charged particles with ranges greater than 6 cm of air produced in the slow neutron fission of U^{233}, U^{235} and Pu^{239} have been studied in detail by coincidence counting methods. In each case particles with a continuous range distribution extending to about 50 cm of air were observed, the distribution showing a broad maximum in the neighbourhood of 20 cm. Direct measurement of the energies of the light particles from U^{235} showed a fairly symmetrical distribution about 15 MeV with a maximum energy of about 26 MeV. Comparison of the energy and range distributions shows that all the long-range particles are α-particles. The frequency of emission of these α-particles was found to be 1 in 405 ± 30 fissions for U^{233}, 1 in 505 ± 50 fissions for U^{235}, 1 in 445 ± 35 fissions for Pu^{239}. No protons were observed, although the apparatus would have detected any with ranges lying between 10 and 100 cm of air. The energy distribution of fission fragments coincident with long-range α-particles was also measured. The usual two peaks were observed indicating asymmetric division of mass, but each peak was shifted to a lower energy than is observed in binary fission. Quantitative comparison of the energies involved showed that, on the average, the total kinetic energy carried away in fission accompanied by α-emission is about equal to

that liberated in binary fission. Possible explanations for α-emission in fission are discussed. A.

539.172.4 : 539.166

1315. Neutron capture γ-rays from Cd, Cl and C. R. WILSON. Letter in *Phys. Rev.*, **80**, 90–1 (*Oct.* 1, 1950).

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

1316. Evidence for the multiple production of mesons in a single nucleon-nucleon collision. J. J. LORD, J. FAINBERG AND M. SCHEIN. *Nuovo Cim.*, **7**, 774–81 (*Sept.* 25, 1950).

A photographic emulsion was exposed to the cosmic radiation at an altitude of 95 000 ft. The nuclear encounter in which the mesons were created was produced by a primary proton of 3×10^{13} eV energy. Directly in line with the incident proton, 7 particles of minimum ionization were emitted in a central core with an angular divergence of 0·003 radian. In addition, 8 other minimum ionization particles were emitted in a wider diffuse cone of 0·13 radian angular divergence. Only one track had the appearance of a fragment which, however, could have been a proton of 10 MeV energy. Most of the particles in the central core had energies in excess of 250 GeV, while those in the diffuse cone were of much lower energies as determined by small angle scattering measurements. A pair of very small angular divergence was produced in the central core 4 800 microns from the point of origin of the nuclear interaction. Assuming that the pair were produced by a gamma-ray from the decay of a neutral meson, a lower limit of 2×10^{-15} sec was deduced for its mean life. Both the angular and the energy distribution of the emitted particles is in good agreement with the assumption that in the centre of mass system the mesons are emitted in two distinct cones of angular width of about 30° forward and backward with reference to the direction of the primary proton. The average multiplicity of 15 agrees with the recent calculation by Fermi, and according to his prediction about one-half of the particles are made up of nucleon-antinucleon pairs. A.

539.18

1317. On the production of nuclear mesons of spin zero by photons. P. BENOIST-GUEUTAL, J. PRENTKI AND J. RATIER. *J. Phys. Radium*, **11**, 553–63 (*Oct.*, 1950) *In French.*

The production of charged and neutral mesons by a photon-nucleon collision is calculated in first Born approximation for the symmetric pseudoscalar and scalar meson theories, allowing nucleon recoil. The ratio of positive and negative mesons created then agrees with the result obtained classically by Brueckner and Goldberger [Abstr. 3405 (1950)]. The total cross-section and the meson spectrum due to the photon spectrum used experimentally are obtained. The hypothesis of pseudoscalar mesons obtains some support from a comparison of these results with the present data. R. H. DALITZ

539.18 : 530.145

The meson as a composite particle. *See Abstr.* 854

539.18 : 530.145

1318. On the mechanism of the emission of nuclear mesons in nuclei. P. CÜER. *C.R. Acad. Sci., Paris*, **231**, 899–901 (*Oct.* 30, 1950) *In French.*

The possibility of meson-emission resulting from the interaction between incident nucleon and a whole nuclear sub-group (e.g. α-particle, triton) is discussed. Detailed calculations (not given) are stated to agree with the experimental excitation curves. E. P. GEORGE

539.181

1319. Secondary electron emission from molybdenum produced by helium, neon, argon and hydrogen. D. GREENE. *Proc. Phys. Soc., Lond. B*, **63**, 876–89 (*Nov.*, 1950).

Experiments have been carried out on the secondary electron emission produced at very low pressure from a degassed metal surface by neutral particles resulting from the neutralization of positive ions of about 1 000 eV energy in a metal canal. The gases used were He, Ne, A and H. For the first three the energy distribution of the secondary electrons is compatible with the view that a large part of the emission is due to communication of the energy of excitation of a metastable atom to a metallic electron. With H there is evidence that a similar process occurs with normally excited states of the atom or molecule. In all cases there is evidence that some emission occurs through local heating or disruption of the metal lattice by the mechanical impact of swift atoms, the extent of this increasing from He and Ne to A and H. Some reflection of the swift atoms occurs from the metal target. A.

539.185

1320. A 200-kV neutron generator. I. G. CARLSON. *Ark. Fys.*, **2**, *Paper* 26, 277–87 (1950).

Describes a neutron generator, constructed at Upsala, which uses the D (d, n) reaction. A low-voltage arc type of ion source is used with targets of heavy ice or heavy water and P_2O_5, the former being preferred. The paper discusses the ion source, accelerator tube, high vacuum equipment and the high tension installation. J. THEWLIS

539.185

1321. A 200-kV neutron generator. II. I. BARTHOLDSON AND G. CARLSON. *Ark. Fys.*, **2**, *Paper* 27, 289–93 (1950).

See preceding Abstr. Discusses the adjustment of the neutron generator and the focusing of the ion beam, the measurement of the ion current and the neutron yield for the heavy ice target cooled with liquid air. The yield at 200 kV and 80 μA of ion current is estimated to be equivalent to about 2 Curies of Ra–Be. J. THEWLIS

539.185

1322. The scattering lengths of the deuteron. D. G. HURST AND N. Z. ALCOCK. Letter in *Phys. Rev.*, **80**, 117–18 (*Oct.* 1, 1950).

539.185

1323. Angular distribution of neutrons elastically scattered by oxygen, carbon and nitrogen. E. Baldinger, P. Huber, R. Ricamo and W. Zünti. *Helv. Phys. Acta*, **23** (*No.* 5) 503–7 (1950) *In German.*

The scattering was measured for various energies, the neutrons being obtained by the D–D reaction, deuterons of energy 100–1 000 kV impinging on heavy ice. Recoil energies were measured in an ionization chamber, a 20-channel kick-sorter being used. Distribution curves are given, showing considerable anisotropy for certain energies, followed by a discussion of the results. J. THEWLIS

539.185

1324. Scattering of fast neutrons by carbon and oxygen. R. Ricamo, W. Zünti, E. Baldinger and P. Huber. *Helv. Phys. Acta*, **23** (*No.* 5) 508–10 (1950) *In German.*

Resonances are observed for C and O in the range of neutron energies from 2·5 to 4 MeV, which give rise to anisotropic scattering in their neighbourhood. The significance of the results for nuclear theory is discussed. J. THEWLIS

539.185

1325. Neutron scattering resonances of lithium. R. K. Adair. Letter in *Phys. Rev.*, **79**, 1018–19 (*Sept.* 15, 1950).

Measurement of the cross-section of Li from 20 to 1 400 keV reveals a resonance at 270 keV, of width 45 keV. By putting these values in an expression for the cross-section, assuming that elastic scattering is the only process involved to an appreciable extent, a value of the phase-shift on scattering is derived. This is found to correspond to a negative scattering length, as observed in practice; but the magnitude of this scattering length can only be regarded as of qualitative value. J. THEWLIS

539.185

1326. A study of the slowing down distribution of Sb^{124}–Be photo-neutrons in graphite, and of the use of indium foils. L. D. Roberts, J. E. Hill and G. McCammon. *Phys. Rev.*, **80**, 6–10 (*Oct.* 1, 1950).

The spatial density distribution of In resonance neutrons (1·44 eV resonance) has been measured around a point Sb^{124}–Be photo-neutron source in a graphite slowing-down medium. This distribution was found to be in agreement with appropriate theory. The source energy of the photo-neutrons was calculated from the measured neutron distribution and a value of 20 ± 4 keV was obtained in fair agreement with values obtained by other methods. It was found that there is a quite appreciable capture cross-section in In^{115} above the 1·44 eV resonance extending in energy to at least several keV. It is shown that this capture of neutrons with energies above 1·44 eV can introduce an error into neutron slowing-down measurements which can be important under some circumstances, and it is shown how this error can be corrected. A.

539.185

1327. Neutron penetration and slowing down at intermediate distances through medium and heavy nuclei. H. A. Bethe, L. Tonks and H. Hurwitz, Jr. *Phys. Rev.*, **80**, 11–19 (*Oct.* 1, 1950).

New theoretical results and numerical calculations are reported, assuming constant mean free path and no absorption. The Placzek one-velocity problem which results from a Laplace transformation of the Boltzmann equation is solved approximately by keeping only a finite number of harmonic terms in the Laplace transform of the scattering function but not restricting the expansion of the neutron density. The Laplace inversion is carried out by the method of steepest descent. Numerical results are given for nuclei of mass infinity and 9, carried out to 3 orders of approximation, namely 0th, 1st and 2nd. They show the expected transition behaviour between age theory and the asymptotic exponential behaviour. The accuracy of the method is high, being greater than that of the numerical work over the useful range of the calculations. Rough agreement with Wick's asymptotic results for $M = 12$ is found. A.

539.185

1328. Neutron scattering cross sections of the noble gases. S. P. Harris. *Phys. Rev.*, **80**, 20–2 (*Oct.* 1, 1950).

The neutron scattering cross-sections of 5 noble gases were measured using a neutron beam and an annular BF_3 proportional counter. B absorption and self-indication techniques were used to detect resonances. A strong neutron resonance was found in Xe and indications of resonances in A and Kr were obtained. A.

539.185

1329. Total cross sections of nuclei for 280-Mev neutrons. R. Fox, C. Leith, L. Wouters and K. R. MacKenzie. *Phys. Rev.*, **80**, 23–6 (*Oct.* 1, 1950).

The measurement of 280 MeV neutron cross-sections of various nuclei is described. The neutron beam used results from 340 MeV protons in the 184 in cyclotron striking a 2 in Be target. The neutron detector consists of a double-coincidence anthracene scintillation counter telescope which counts recoil protons scattered at 15° from a paraffin cylinder placed in the collimated neutron beam. A 2 in Cu absorber placed between the counters assures that only protons of energy greater than 250 MeV are counted. The cross-sections for all nuclei measured from Li to Pb are smaller than the corresponding cross-sections measured at 85 MeV by factors between 0·5 and 0·6. A.

539.185

1330. Nuclear cross sections for 270-Mev neutrons. J. DeJuren. *Phys. Rev.*, **80**, 27–30 (*Oct.* 1, 1950).

The total cross-sections of 11 different elements were measured for the neutrons resulting from the bombardment of a 2-in Be target by the 350-MeV protons of the 184-in cyclotron. Bi fission ionization chambers served as the neutron detectors and had an estimated mean neutron detection energy of 270 MeV for the measurements. The attenuating materials were placed inside the concrete shielding and the monitor was placed to one side of the attenuators. The detector was placed about 30 ft from the attenuators in line with the target and the attenuators. Collimators in the concrete shielding and a concrete block immediately behind the attenuating materials limited the detection of neutrons scattered through small angles to 20 min. "Poor" geometry cross-sections of C, Cu and Pb were

measured by placing a shallow fission chamber behind attenuators of large cross-sectional area over which the neutron flux was uniform. The inelastic cross-section is at least half the total for all three elements. A.

539.185

1331. On the theory of slow neutron scattering by solid and liquid helium. L. GOLDSTEIN AND D. W. SWEENEY. *Phys. Rev.*, **80**, 141–4 (*Oct.* 15, 1950).

The slow neutron scattering properties of solid and liquid He are studied on the assumption that these condensed phases have similar crystal structures. It is shown that, according to this limiting solid model, liquid He, in contrast with usual structures, should exhibit a smoothly increasing total scattering cross-section from the lowest group of neutron energies available at present up to those higher energies at which the asymptotic, free atom cross-section value should be approached. Neutron transmission experiments at various energies should enable one to determine whether this liquid scatters slow neutrons as a solid or not, and if the two liquid modifications have similar or dissimilar slow neutron scattering properties. A.

539.185

1332. The inelastic scattering of high energy neutrons by deuterons according to the impulse approximation. G. F. CHEW. *Phys. Rev.*, **80**, 196–202 (*Oct.* 15, 1950).

The high energy $n - d$ inelastic scattering problem is formulated in such a way that the amplitudes for $n - n$ and $n - p$ scattering at the same energy appear explicitly. The formulation depends on: (1) the large radius of the deuteron compared with the range of nuclear forces and high energy scattering amplitudes; (2) the high velocity of the incident neutron compared to the zero point motion of the deuteron. The method does not depend on the weakness of nuclear forces compared to the kinetic energy of the neutron and is therefore not equivalent to the Born approximation. A.

539.185.08

1333. The design of neutron counters using multiple detecting layers. R. D. LOWDE. *Rev. Sci. Instrum.*, **21**, 835–42 (*Oct.*, 1950).

A discussion is given of ion chambers in which a series of electrodes carry layers of solid detecting material. Counters of this type require low operating voltages, and can easily be miniaturized. Formulas are given for the correct layer thicknesses and for the neutron counting efficiency. The equations are applied to B^{10}, and it is shown that there is a permissible tolerance of about 50% on the thickness of a B layer, and a very considerable tolerance on the assumed values of the disintegration product ranges. Curves are given relating the optimum B layer thicknesses and the efficiency to the number of layers. A miniature instrument is described having a sensitive volume of 0·4 cm³. It operates at a thermal neutron efficiency of 24% with a collecting voltage of 70. A.

539.185.7 : 539.166.75 : 614.898

1334. Shielding properties of the concrete wall of the M.I.T. cyclotron. V. DELANO AND C. GOODMAN. *J. Appl. Phys.*, **21**, 1040–7 (*Oct.*, 1950).

The shielding properties of the four-foot concrete wall of the M.I.T. cyclotron have been studied, using foils for neutrons and X-ray films for gammas. Fast neutrons were measured by counting the beta-active products of $Al^{27}(n, p)Mg^{27}$, $Fe^{56}(n, p)Mn^{56}$, and $Al^{27}(n, \alpha)Na^{24}$ reactions, thermal activation being eliminated by Cd holders. Resonance (1·44 eV) and thermal neutron distributions, measured by Cd-In-Cd and In, with suitable corrections, were reduced to absolute intensities by comparison with a known flux. Measurements were made with cylindrical concrete blocks fitted into a 4½ in dia. hole which extended through the concrete wall. The results indicate an attenuation factor of 8·3 per foot for the fast neutron component and 10 per foot for thermal neutrons. An estimate of the fast neutron flux above 4·5 MeV showed a transmitted intensity slightly higher than the presently accepted tolerance value when bombarding Be. The absolute thermal neutron flux was below the tolerance level. The r.m.s. distance and the diffusion length for thermal and resonance neutrons in concrete were estimated by considering the distributed source to be equivalent to a point source at the inner face of the wall. The gamma-ray measurements were not convertible to roentgens. A mean energy of 2·7 MeV was obtained for the gamma-radiation within the wall. The attenuation factor for total gamma-radiation in the wall at large distances from the inner face was 5·9 per foot. A.

STRUCTURE OF SOLIDS 539.2

539.2 : 539.11

Order–disorder for Coulomb forces. *See Abstr.* 1211

539.211 : 535.371

1335. The metallurgical examination of surfaces by fluorescence. M. DÉRIBÉRÉ. *Rev. Metall.*, **47**, 704–5 (*Sept.*, 1950) *In French.*

Some brief details, additional to author's previously published work [*Comm. Maison Chimie* (*June* 4, 1948)], of the chemicals and procedure used in the process of showing up cracks and faults by illuminating a treated surface with u.v. light, together with an outline of the whole operation. A. J. KENNEDY

539.211 : 620.179.6 : 621.357.7

1336. An electro-deposited surface roughness standard. P. M. AITCHISON. *Aust. J. Appl. Sci.*, **1**, 71–4 (*March*, 1950).

The standard consists of a lapped steel block on which are deposited thin strips of Cr of specified width, spacing and height. This provides a known surface for use in the calibration of stylus-type, surface-finish measuring instruments. A.

539.215

1337. Application of dilatometry to powder metallurgy. J. H. ANDREW AND G. S. TENDOLKAR. *J. Sci. Industr. Res.*, **9B**, 244–7 (*Oct.*, 1950).

A modified horizontal dilatometer has been designed and used to study volume changes of pressed copper powder specimens during heating.

The characteristic of the curves showing the relationship between linear expansion and temperature vary with particle size and compacting pressure. Porosity and gas absorption are the two factors which influence expansion in the early stages of heating. Surface tension is the dominating factor at high temperature. A.

539.215.4 : 548.5

1338. The distribution of particle sizes. F. KOTTLER. *J. Franklin Inst.*, **250**, 339–56 (*Oct.*, 1950).

The older literature on distribution of particle sizes is reviewed critically. The distribution law should be connected with the law of growth of crystals, for which is chosen the exponential law as Galton indicated long ago in an analogous case. The law which then follows is the so-called Logarithmico–Normal law. In the application of that law to experimental data, graphical analysis by means of special charts is generally used. It is shown why this purely graphical method should be replaced by an algebraic one, such as is used, for instance, in psychophysics with a similar problem. A.

539.217

1339. Self-diffusion in tin crystals. P. J. FENSHAM. *Aust. J. Sci. Res. A.*, **3**, 91–104 (*March*, 1950).

The rate of self-diffusion in single crystals of white Sn of various orientations has been measured using the radioactive isotope Sn^{113}. The ratio of the diffusion coefficients parallel and perpendicular to the tetragonal (c) axis is approximately 2 at 180°C and approximately 3 at 223°C. The diffusion coefficients in both directions at various temperatures are given by the Arrhenius expressions $D_c = 1{\cdot}2\times10^{-5}e^{-10,500/RT}\,\mathrm{cm^2sec^{-1}}$ and $D_a = 3{\cdot}7\times10^{-8}e^{-5,900/RT}\,\mathrm{cm^2sec^{-1}}$. The anisotropy is discussed in terms of the vacancy mechanism of diffusion. A.

539.217

1340. Self-diffusion in polycrystalline tin. P. J. FENSHAM. *Aust. J. Sci. Res. A*, **3**, 105–8 (*March*, 1950).

The rate of volume diffusion in polycrystals of Sn, as indicated by the darkening of photographic films, is in general agreement with the previous measurements of the rate of self-diffusion in different crystallographic directions. The rate of diffusion along the grain boundaries is generally considerably higher than that of volume diffusion except when the boundary is that between twins or between crystals of similar orientations. These observations are discussed in terms of recent theories of the grain boundary and the vacancy mechanism of diffusion. A.

539.217

1341. Self-diffusion in cobalt. F. C. NIX AND F. E. JAUMOT, JR. Letter in *Phys. Rev.*, **80**, 119 (*Oct.* 1, 1950).

539.217

1342. Electrical conductivity method for measuring self-diffusion of metals. J. H. DEDRICK AND G. C. KUCZYNSKI. *J. Appl. Phys.*, **21**, 1224–5 (*Dec.*, 1950).

Measurement is made of the contact conductance of an interface between two metallic spheres or hemispheres. By combining Kuczynski's equation for self-diffusion with Bowden and Tabor's equation for the contact conductance between two metallic spheres a relationship has been obtained between contact conductance and the time of heating of the spheres. Thus by measurement of junction conductance as a function of time of heating, for different temperatures, diffusion coefficients and the heat of self-diffusion can be evaluated in the normal manner. A similar relationship has been obtained for two spheres or hemispheres initially pressed together to give a known contact conductance before heating.

539.217

1343. Coefficient of self-diffusion of copper. G. COHEN AND G. C. KUCZYNSKI. Letter in *J. Appl. Phys.*, **21**, 1339–40 (*Dec.*, 1950).

See Abstr. 7527 (1950).

539.23 : 539.27

1344. On the structure of monolayers and multilayers of polar hydrocarbon molecules on solid substrates. H. EPSTEIN. *J. Phys. Coll. Chem.*, **54**, 1053–69 (*Oct.*, 1950).

Monolayers and multilayers of the normal fatty acids on solid substrates have been examined by electron microscopy and electron diffraction. The main result is the observation that the molecules are grouped into two-dimensional micelles, about 100 Å in diameter. Several inconsistencies and errors in previous work are resolved and corrected. An order of magnitude theory of micelle structure is developed, and preliminary experiments indicate that its predictions are at least qualitatively correct. The theory relates the micelle diameter, the observed maximum tilt of molecules in a monolayer, and the length of the molecule. Skeletonized films are examined, and it is observed that deep holes develop in such films. A mechanism for skeletonization is proposed and is found not to be inconsistent with the very limited amount of data available on skeletonized films. A.

539.232

1345. On the capacity of porous aluminum oxide layers. A. J. DEKKER AND H. M. A. URQUHART. *Canad. J. Res. B*, **28**, 541–50 (*Sept.*, 1950).

Porous Al_2O_3 layers may be obtained by anodic oxidation in sulphuric acid. The base of the pores is separated from the metal by a thin insulating barrier layer. The experiments show that the ultimate thickness of the barrier layer remains constant after a critical value has been reached. The dependence of the final thickness on current density, concentration and temperature has been investigated. It is suggested that an electronic current is involved in the mechanism which limits the growth of the barrier layer. A.

539.234

1346. Absorption of nitrogen by evaporated film of barium. T. ARIZUMI AND K. IMAEDA. *J. Phys. Soc., Japan*, **5**, 169–73 (*May–June*, 1950).

The reaction between Ba and N_2 was studied experimentally over a range of temperature. It was found not to be simple adsorption but to involve nitrate formation. L. G. CARPENTER

539.234

1347. Preparation of carbon targets. G. C. PHILLIPS AND J. E. RICHARDSON. Note in *Rev. Sci. Instrum.*, **21**, 885–6 (*Oct.*, 1950).

539.234 : 535.421

1348. Two improved methods of graticule production using evaporated metal films. P. M. AITCHISON AND R. E. AITCHISON. *Aust. J. Appl. Sci.*, **1**, 75–9 (*March*, 1950).

In the first the glass is coated with an evaporated metal film and then a wax resist, and the graticule ruled, etched and filled if necessary. By careful choice of the undercoating metal greatly improved results over those obtained by normal procedures are possible. In the second the glass is coated with an evaporated metal film, then ruled, and a second (different) metal evaporated on to the surface. By use of a preferential solvent, the undercoat is removed leaving a graticule of the second metal. All etching and filling processes are thus eliminated. A.

539.234 : 537.533.72

1349. Continuous observations with the electron microscope on the formation of evaporated films of silver, gold, and tin. T. A. MCLAUCHLAN, R. S. SENNETT AND G. D. SCOTT. *Canad. J. Res. A*, **28**, 530–4 (*Sept.*, 1950).

A special specimen holder has been constructed for the evaporation of metals within an RCA–EMU electron microscope. This provides continuous observations on the growth of films of the metal. Micrographs are reproduced which illustrate the formation of films of Ag, Au and Sn. The results confirm the usually accepted assumptions regarding the formation of nuclei and the growth of aggregates. A.

539.234 : 548.5

1350. A note on the orientated overgrowths of metal films on single crystal inorganic substrates. H. R. THIRSK. *Proc. Phys. Soc., Lond. B*, **63**, 833–9 (*Nov.*, 1950).

Some new examples of metal crystal orientations on inorganic substrates are described. They include Ag and Fe on mica, Pt on the cube face of KCl, Fe and Ag on the (111) face of KCl, Ag and Ni on the cube face of MgO. Some of the problems involved in the study of the types of crystal growth are discussed briefly for the cases examined. A.

539.26

1351. Microradiographic study of grain boundaries in pure Al and the solid solution Al–Zn during melting. A. BERGHEZAN, P. LACOMBE AND G. CHAUDRON. *C.R. Acad. Sci., Paris*, **231**, 576–8 (*Sept.* 18, 1950) *In French.*

Observations of the fusion of grain boundaries in pure Al show that melting takes place first in small localized regions in the boundary. In Al–Zn, as melting commences there is a diffusion of Zn into the grain boundaries. A. E. DE BARR

539.26

1352. X-ray examination of clay minerals. H. TAZAKI AND K. MIYANO. *J. Sci. Hiroshima Univ., Ser. A*, **14**, 151–4 (*March*, 1950).

Specimens were kaolin, montmorillonite and muscovite from Japanese paddy soil. Intensities of diffraction lines and their spacings are given.

A. R. STOKES

539.26 : 541.182.5

1353. Study of the silica gel by the central scattering of X-rays. B. IMELIK AND Y. CARTERET. *C.R. Acad. Sci., Paris*, **231**, 280–2 (*July* 24, 1950) *In French.*

If the electronic density of the adsorbed phase is essentially equal to or larger than that of the adsorbing phase, adsorption on silica gel may be proved and studied by the method of small-angle scattering of X-rays. Thus the distribution function of the pores, their size and the radius of gyration were found. The question whether the scattering observed characterizes the pores or the particles is tentatively answered in favour of the former. The tests were made with vapours of H_2O, CCl_4 and I and at different vapour pressures. The development of the scattering characteristics of these substances helps to explain the origin of the scattering. R. NEUMANN

539.26 : 669.018

1354. On the interpretation of the scattering of X-rays by precipitation-hardening alloys. A. GUINIER. *C.R. Acad. Sci., Paris*, **231**, 655–7 (*Oct.* 2, 1950) *In French.*

Suggests that the observed diffuse X-ray reflection from alloys such as Al–Cu may be explained if it is supposed that the precipitated zones do not merely increase in size as precipitation continues, but also change their structure and composition.

A. E. DE BARR

539.26 : 669.225.721

1355. The superstructure in the α phase of silver–magnesium alloys. L. M. CLAREBROUGH AND J. F. NICHOLAS. *Aust. J. Sci. Res. A*, **3**, 284–9 (*June*, 1950).

X-ray and electrical resistivity studies of a Ag–Mg alloy containing 25 atomic % of Mg are described. From the results, it is concluded that a superlattice exists at this composition, the order-disorder transformation occurring between 386 and 389°C. A.

539.26 : 669.35.21

1356. Local order in solid Cu_3Au. R. A. ORIANI. Letter in *J. Appl. Phys.*, **21**, 1068–9 (*Oct.*, 1950).

X-ray diffraction data [Abstr. 2782 (1950)] on the degree of order around 500°C are shown to agree satisfactorily with activity data from (1) e.m.f. measurements, (2) heat of solution measurements.

A. R. STOKES

539.27

1357. A microtome specimen holder advanced by thermal expansion. M. EDEN, A. W. PRATT AND H. KAHLER. *Rev. Sci. Instrum.*, **21**, 802–4 (*Sept.*, 1950).

The holder was heated by an electrical current, the value of which could be regulated to give any desired rate of heating and expansion. A quantitative comparison was made between the heating and expansion rates of the Newman, Borysko and Swerdlow CO_2 precooled instrument and the electrically heated instrument. It was found that the electrically heated specimen holder fulfilled the requirements of flexibility, reproducibility, sensitivity and linearity. A.

539.27

1358. Electron microscopy of wet biological tissues by replica techniques. I. W. FISCHBEIN. *J. Appl. Phys.*, **21**, 1199–204 (*Dec.*, 1950).

Study of the tissues *in situ* was made possible by modifying existing replica techniques and developing

a new wet replication method. Replicas of wet tissues were produced in extremely thin polystyrene films which could be observed directly in the electron microscope; however, superior results were obtained by preparing silica replicas from the replicated polystyrene films. A modified two-replica silica method proved satisfactory but the three-replica silica method developed was preferable. Electron micrographs of wet wood fibre surfaces used to illustrate these techniques reveal new data concerning submicroscopic cell-wall structure. The problem of interpreting replicas of partially degraded and disorganized materials is illustrated and discussed briefly. A.

ELASTICITY . STRENGTH . RHEOLOGY 539.3/.8

539.31

1359. On a variational theorem in elasticity. E. Reissner. *J. Math. Phys.*, **29**, 90–5 (*July*, 1950).

A new variational method is proposed for obtaining approximate solutions of boundary value problems, which, unlike earlier methods, gives equal weight to the stress-equilibrium equations and the stress-displacement relations. Its advantages are illustrated in deriving two-dimensional equations for the transverse bending of plates. A. T. PRICE

539.31

1360. A linear theory of finite strain. A. N. Gordon; K. H. Swainger. Letter in *Nature, Lond.*, **166**, 657–9 (*Oct.* 14, 1950).

The attempt by K. H. Swainger [Abstr. 5701 (1949), 4398 (1950)] to develop a linear theory of elasticity for finite strains is shown to fail because the "straining-displacement", on which the theory is based, exists only for irrotational strains. In a reply Dr. Swainger states that this argument is not applicable to his theory. A. T. PRICE

539.32

1361. Comment on "Relationship between Gough–Joule coefficients and moduli of vulcanized rubbers". M. Mooney. Letter in *J. Appl. Phys.*, **21**, 1338 (*Dec.*, 1950).

See Abstr. 5697 (1949).

539.32 : 534.321.9

1362. Determination of elastic constants of solids by pulse method. Krishnaji. *Proc. Nat. Inst. Sci., India*, **16**, 227–34 (*July–Aug.*, 1950).

A short summary is given of Knott's theory relating to a plane longitudinal wave incident upon the interface of a liquid and an isotropic elastic solid and it is shown how the elastic constants of the solid can be deduced from observations of the energy transmitted by the solid for different angles of incidence. A pulse method using a quartz crystal transducer operating at 2·5 Mc/s is described with which the elastic constants of Al, Fe, brass and Malabar stone were measured. See also Abstr. 2153 (1949). H. J. H. STARKS

539.32 : 548.0

1363. An approximation method for the determination of the elastic constants of cubic single crystals. J. R. Neighbours and C. S. Smith. Letter *J. Appl. Phys.*, **21**, 1338–9 (*Dec.*, 1950).

Extension of Abstr. 670 (1951).

539.3

1364. On the theory of dislocations. J. L. Boc Danoff. *J. Appl. Phys.*, **21**, 1258–63 (*Dec.*, 1950).

If, in a multiply-connected elastic solid, disco tinuities are permitted across a stationary barrier either the strain or its first derivatives or bot dislocations of a more general type than encountere in classical theory are possible. A number of the more general dislocations have been obtained f states of plane and anti-plane strain in a hollow rig circular cylinder when the surface of discontinuity a single stationary plane barrier. Some of th dislocations found possess the characteristic th although the strain is continuous across the barri the displacement discontinuity is not one which wou be possible in a rigid body. Examination of th conditions for the uniqueness of solution of th boundary value problems of elasticity reveals th when dislocations of the more general type a admitted appropriate data must be given at eac point on the specified barrier in addition to the usu information.

539.3

1365. Deformations and stresses in Bourdon tube R. A. Clark and E. Reissner. Letter in *J. App Phys.*, **21**, 1340–1 (*Dec.*, 1950).

539.3

1366. A contribution to the study of the mechanism of rupture in metals. G.-A. Homès and J. Gouzo *Rev. Métall.*, **47**, 678–92 (*Sept.*, 1950) *In French.*

A statement of experimental observations on Z and mild steel using photographic and X-ray method providing qualitative data over a range of exper mental conditions for the 2 glide systems. Specime have been photographed at the instant of fractur and the operative mechanisms distinguished. Pr mature cleavage in the Zn grains is frequent and is n necessarily the cause of fracture. A completely inte crystalline failure has not been observed in eith material. Quantitative measurements have bee made on the deformation of adjacent zones, and the are compared with the overall extension as measure by the instrument. Marked discontinuities have bee obtained, associated with the appearance of slip lin in the crystals of the zone concerned. A. J. KENNED

539.3

1367. Deformation and recrystallization of alloy containing two phases. L. M. Clarebrough. *Aust. Sci. Res. A*, **3**, 72–90 (*March*, 1950).

Using mainly Ag–Mg alloys, the deformation the phases was determined from observations of sli lines and recrystallization behaviour. The relativ deformation of the two phases is influenced both b the total deformation of the alloy and by the volum fractions of the phases. When very little of the har β phase is present most of the deformation occurs i the soft α crystals and there is additional flow of th matrix around the hard particles. If the proportio of the β phase is not greater than 30% by volume th soft α deforms more than the β for reductions of u to 60%, but for heavier reductions the two phase deform more uniformly. When both phases ar

present in about equal proportions they deform to the same extent. The recrystallization behaviour of the phases in a duplex alloy is affected by the state of order of the phases, and by precipitation occurring in one of the phases on annealing the deformed alloy. Experiments were designed to show the influence of various factors and the general case of recrystallization of the phases in slowly cooled and quenched Ag–Mg alloys is interpreted in terms of the results. The inhomogeneity of deformation of the phases is indicated by their mode of recrystallization. A.

539.374

1368. Plastic flow of platinum wires. R. P. Carreker, Jr. *J. Appl. Phys.*, **21**, 1289–96 (*Dec.*, 1950).

The strain-time behaviour of annealed Pt wires at constant stress and temperature is reported for a wide range of experimental conditions, namely: 1 550 to 78°K, 900 to 40 000 lb/in², 0·001 to 0·1 strain, 10^{-1} to 10^{-6} min^{-1} strain rate. Relations were found which describe the results satisfactorily. A.

539.374

1369. Plastic deformation. P. Cicala. *Atti Accad. Naz. Lincei* (*R.C. Sci. Fis. Mat. Nat.*) **8**, 583–7 (*June*, 1950) *In Italian.*

The main features of the many diverse theories of plastic deformation due to a body having undergone an elastic strain are described. An idea of Batdorf and Budiansky based on the concept of slip is examined mathematically by tensor analysis. Agreement of the resultant formula with experiment is good when applied to various particular examples. C. A. HOGARTH

539.374

1370. Deviations from Hooke's law and the domain of stability. A. Kammerer. *C.R. Acad. Sci., Paris*, **231**, 681–3 (*Oct.* 9, 1950) *In French.*

A non-linear stress-strain relation is used to define the limiting surface of the region of stability.

J. E. CAFFYN

539.374

1371. A theory of the plastic bulging of a metal diaphragm by lateral pressure. R. Hill. *Phil. Mag.*, **41**, 1133–42 (*Nov.*, 1950).

Explicit formulae are obtained for the stresses in a metal diaphragm which is bulged plastically by lateral pressure. The predicted influence of work-hardening on the shape of the profile, and on the relation between polar strain and curvature, agrees well with experimental data. A simple expression is developed for the instability strain. A.

539.374 : 532.516

1372. Friction and viscosity in plastic bodies. F. Charron. *C.R. Acad. Sci., Paris*, **231**, 646–7 (*Oct.* 2, 1950) *In French.*

A frictional coefficient f and a viscosity coefficient η can be associated with a readily deformable plastic body, such as a grease, in such a way that the shear stress X is related to the velocity gradient u_z by the equation $X = f + \eta u_z$. Boundary conditions are more complicated than for viscous flow, depending on the roughness of the solid boundaries, and special precautions must be taken in practice to prevent slipping. J. G. OLDROYD

539.374 : 537.311.33 : 548.0

Influence of plastic flow on the electrical and photographic properties of the alkali halide crystals. *See Abstr.* 1477

539.374 : 548.0

1373. Deformation textures in face-centred cubic metals. E. A. Calnan and C. J. B. Clews. *Phil. Mag.*, **41**, 1085–100 (*Nov.*, 1950).

The treatment is based on the following concepts. The constraints exerted by neighbouring grains prevent the resolved shear-stress from reaching the critical value, and the direction of the effective stress, T, moves away from the direction of the applied stress so that T resolved on the most favourable system is always $<$ critical. In a fine-grained aggregate, the direction of movement may be taken to be perpendicular to the shear-stress contours. The corner points of the unit triangle are minimum positions, any increase in T now resulting in slip. Accepting this, the relationship between tensile stress and elongation may be approximately derived from the single-crystal shear-hardening curve assuming T has reached a corner point in all the grains (even though, for deformation textures to occur, this cannot be true). Agreement with experiment is as good as the Taylor theory. Tension, compression, rolling and drawing textures are derived, all in reasonable agreement with observation. A. J. KENNEDY

539.374 : 548.4

The influence of deformation by Piobert lines on the changing of Fe with cathodic H. *See Abstr.* 1486

539.4 : 669

1374. The physics of the deformation of metals. E. N. da C. Andrade. *Endeavour*, **9**, 165–77 (*Oct.*, 1950).

Methods are enumerated for revealing the crystalline grain structure of metals and a brief account is given of the interatomic forces on which depend the behaviour of metallic crystals under stress. The large discrepancy between actual behaviour and that theoretically predicted is even more marked in the case of metal single-crystals. Stretched metal single-crystals have a band structure and it is believed that deformation takes place by slipping along glide planes. This sliding is attributed to the propagation of dislocations, which is illustrated by models. Impurities hinder this propagation and harden the metal and the behaviour of single-crystals can only be explained by a system of structural irregularities. Creep at high temperatures and pressures is considered and an equation governing this phenomenon is interpreted.

539.4.016.2

1375. Density variations in aluminium. J. L. Snoek. *Phil. Mag.*, **41**, 1188–92 (*Nov.*, 1950).

From careful determinations of the density of samples of Al in various conditions the conclusion is drawn that grain boundaries in Al may have a more spacious structure than is generally assumed. A.

539.434

1376. Creep in a precipitation-hardened alloy. M. Davis and N. Thompson. *Proc. Phys. Soc., Lond. B*, **63**, 847–60 (*Nov.*, 1950).

Measurements have been made of the creep shown by polycrystalline wires of a hardened alloy (Cu + 3%

Ag) both at room temperature and 90°K. The results are interpreted in terms of the Mott–Nabarro theory of transient creep. The agreement between theory and experiment is qualitatively good, and the quantitative discrepancies suggest directions in which the existing theory might be refined. A.

539.434 : 548.0

1377. Surface effects in creep of cadmium crystals. D. J. Phillips and N. Thompson. *Proc. Phys. Soc., Lond. B*, **63**, 839–47 (*Nov.*, 1950).

A recording rate-of-strain meter has been used to investigate the changes in creep rate when the chemical environment of a stressed Cd crystal is altered. Experiments were made with aqueous solutions of a number of inorganic salts of Cd. The observations are explicable in terms of variations in the thickness of a surface film of $Cd(OH)_2$, the presence of such a film having the effect of reducing the creep rate by an amount depending on its thickness. Measurements were also made on the effect of very thin films, formed by immersion in distilled water; these were estimated to be about 10^{-6} to 10^{-7} cm thick. When the films were removed with dilute H_2SO_4 a sudden small strain increment was observed, the magnitude of which depended on the film thickness. Possible explanations are discussed. A.

539.501 : 539.434

1378. The rheological properties of dielectric polymers. W. Lethersich. *Brit. J. Appl. Phys.*, **1** 294–301 (*Nov.*, 1950).

The rheological properties of a number of dielectrics have been studied by the application of shear stress to a cylindrical tube of the material. Creep under constant stress has been measured over periods ranging from a few msec to 18 months after applying the stress and the dynamic modulus and internal friction coefficient have been measured over a frequency range of 10^{-4} to 10^{3} c/s. The results obtained indicate that the rheological properties can be expressed in terms of a distribution of mechanical relaxation times. This distribution is hyperbolic for a range of times from 10^{-3} to 10^{7} sec and enables creep and dynamic measurements to be correlated. A.

539.501 : 539.434

1379. Apparatus for the study of creep of dielectric polymers and their dynamic rheological properties. W. Lethersich. *J. Sci. Instrum.*, **27**, 303–6 (*Nov.*, 1950).

Apparatus is described for applying a shear stress rapidly to solid materials and for measuring the strain a few msec afterwards. The apparatus can also be used for measuring the dynamic modulus and internal friction coefficient over a range of frequency from 30 to 1 000 c/s. A modified form of the apparatus enables the frequency range to be extended down to 10^{-4} c/s. A.

539.501 : 541.182.5

1380. Rheological changes during gel formation in adhesive systems. H. G. Higgins and K. F. Plomley. *Aust. J. Appl. Sci.*, **1**, 1–20 (*March*, 1950).

A method of obtaining experimental consistency curves for systems of rapidly changing rheological properties has been developed and has been used in the study of the gelation of various casein glues and synthetic resin adhesives. The nature of the sol-gel transformation and the accepted criteria of a gel a briefly examined in the light of the observations. Th significance of yield value is discussed in relation t the following topics: concentration of polyme unsolvated material, molecular shape, secondar bonds, network structure and cross-linking. Son technological applications of rheology in the field adhesives are indicated.

539.53 : 66

1381. The hardness of glass. W. H. Willot *J. Soc. Glass Techn.*, **34**, T77–9 (*June*, 1950).

The resistance of glass to grinding and the resistanc to indentation do not provide the same measure o hardness. Since resistance to grinding is of wide spread importance in the glass industry, the autho has attempted to measure it in terms of the volume o glass per minute removed by grinding by a specifi abrasive applied under a fixed pressure. From th "grinding hardness" (G.H.) values so obtained fo glasses of differing composition, factors have bee calculated for the effect of each 1% of the oxid present. The highest values are those of the glass forming oxides silica and boric oxide.

539.56 : 66

1382. Some views on the breaking of glass derive from the examination of fracture surfaces. H. M Bateson. *J. Soc. Glass Techn.*, **34**, 114–18 (*Jun* 1950).

Following up the work of F. W. Preston in th U.S.A. and of J. B. Murgatroyd in this country o fractures in glass, it is suggested that rib marks ar ripples on the fracture surface, the suggestion bein based on the formation of intersecting ripples unde suitable conditions. Further evidence that hackle i the result of an independent fracture within the bod of the glass is provided. The possibility of a shoc front being its cause is discussed. A

539.62

1383. Frictional relaxation oscillations. J. R Bristow. Letter in *Proc. Phys. Soc., Lond. B*, 6 964 (*Nov.*, 1950).

In stick-slip phenomena, arising from frictio between an elastically restrained body and a drive surface, there is not in general a part of the cycle i which the two surfaces are at rest relative to eac other—a criticism of the theories of Dudley an Swift [Abstr. 5973 (1949)] and Parker and Hatc [Abstr. 5366 (1950)]. J. G. Oldroyd

539.62

1384. Frictional relaxation oscillations. R. C Parker and D. Hatch. Letter in *Proc. Phys. Soc. Lond. B*, **63**, 964–5 (*Nov.*, 1950).

Reply to preceding Abstr. A more detailed explanation of stick-slip phenomena based on the authors' theory [Abstr. 5366 (1950)]. J. G. Oldroyd

539.67 : 548.

1385. Variation of amplitude-dependent interna friction in single crystals of copper with frequency and temperature. A. S. Nowick. *Phys. Rev.*, **80**, 249–5 (*Oct.* 15, 1950).

The amplitude-dependent internal friction which originates in the motion of dislocations in single crystals of Cu is studied as a function of frequency and temperature. Quantities are introduced which express the dependence of internal friction and o

Young's modulus on strain amplitude and it is shown that these quantities are significant measures of the properties of a crystal. Measurements made between − 60°C and + 33°C show that the observed internal friction can be expressed as the product of a function of temperature and a function of amplitude alone. The data also indicate that the internal friction and elastic modulus are frequency independent when the structure sensitivity of the material is taken into account. The results are considered in terms of two viewpoints: a mechanism of relaxation by which dissipation is controlled through a rate process, and simple hysteresis, by which the stress-strain loop is independent of the rate of traversal. It is shown that the latter mechanism gives much better agreement with the experimental facts. Finally, simple hysteresis is interpreted in terms of the dislocation theory. A.

539.893

1386. Research and technique in the region of high pressures. L. DEFFET. *J. Phys. Radium*, **11**, 489–500 (*Aug.–Sept.*, 1950) *In French.*

High pressures (~ 10 000 atm.) are obtained by a suitably designed Bramah press and measured by a Bourdon gauge. Full details of the apparatus are given, together with the method of use. It is found that the breaking pressure of cylinders at such pressures is 4 to 5 times the theoretical value, probably due to a change in properties of the inner surface. The apparatus is being used to investigate the fusion and transition curves of organic substances, the flow of fluids through tubes, the zero change of manometers due to permanent strains, the effect of pressure on sera used for immunization, and for the calibration of piezo-electric manometers. N. CORCORAN

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.115

1387. Equilibrium at low pressure in the reduction of barium oxide by carbon. C. BROWN. *J. Chem. Phys.*, **18**, 1311–13 (*Oct.*, 1950).

An experimental scheme to investigate the reduction equilibrium of BaO by C is described and analysed critically. Exploratory results at 950° support the analysis and indicate equilibrium at CO pressures below 100 μ with Ba vapour pressures in the range 0·1 to 0·3 μ. The resulting value for the free energy of formation of BaO is − 114 000 cal per mole. A.

541.123.2

1388. A thermodynamical investigation of the system benzene-diphenyl. I. J. H. BAXENDALE, B. V. ENÜSTÜN AND J. STERN. **II–IV.** J. H. BAXENDALE AND B. V. ENÜSTÜN. *Philos. Trans A*, **243** (*No.* 862) 169–96 (1950).

541.123.5

1389. Exchange reactions of uranium ions in solution. E. RONA. *J. Amer. Chem. Soc.*, **72**, 4339–43 (*Oct.*, 1950).

Exchange reactions between U (IV) and U (VI) in HCl solutions have been studied. It was found that the reaction is of the 1st order with respect to the U (VI), 2nd order with respect to the U (IV), and minus 3rd order with respect to the H ion concentration. The rates of exchange did not change with added inert salt, with chloride ion concentration, nor with illumination. The apparent heat of activation was found to be 33 400 ± 800 cal per mole. A mechanism is proposed for the exchange. A.

541.123.5

1390. Isotopic exchanges between cobalt and tantalum and their ions in solution. M. COTTIN. *C.R. Acad. Sci., Paris*, **231**, 697–9 (*Oct.* 9, 1950) *In French.*

Previous work [*J. Chim. Phys.*, **45**, 207, 224 (1948)] on active metals is now continued with the passive metals Co and Ta, and with the chloride, sulphate, nitrate, acetate and perchlorate of Co, and with Ta in HF. The metals have been polished both mechanically and electrolytically. The isotopic exchanges between Co and Ta and their ions are much weaker than for active metals, and almost nil for Ta. The conclusions drawn for Co are: Exchange (1) depends on the nature of the anion; (2) slackens considerably for the nitrate, acetate and perchlorate after 5 min, and follows the empirical law $x = bt^a$ for the sulphate and chloride; (3) is favoured by surface attack and weakened by polishing and by an inert atmosphere (N_2); and (4) increases with temperature. H. H. HODGSON

541.124

1391. Walden inversion and reaction mechanism. E. D. HUGHES, C. K. INGOLD, R. J. L. MARTIN, D. F. MEIGH AND C. A. BUNTON. *Nature, Lond.*, **166**, 679–80 (*Oct.* 21, 1950).

Fresh experimental evidence is advanced for the view that unimolecular substitutions of alkyl compounds involve racemization with excess of inversion, the excess diminishing when conjugation increases the stability of the intermediate alkyl cation. A. J. MEE

541.126

1392. Kinetics of OH radicals from flame emission spectra. I. Vibrational transition probabilities, intensities, and equilibrium in the $^2\Sigma^+ - {}^2\Pi$ transition. K. E. SHULER. *J. Chem. Phys.*, **18**, 1221–6 (*Sept.*, 1950).

The relative vibrational transition probabilities for the first 4 vibrational levels of the $^2\Sigma^+ - {}^2\Pi$ system of OH have been calculated. Anharmonic wave functions derivable from the Morse potential function were used and the electronic dipole moment matrix component appearing in this formulation has been evaluated. Relative intensities for the various bands have been calculated under the assumption of thermal equilibrium. Comparison of these calculated values with the data of Dieke and Crosswhite on the oxy-acetylene flame at one atm. indicate vibrational equilibrium with a vibrational temperature of ~ 3 750°K in the outer cone which compares with a rotational temperature of ~ 3 000°K. The relationship between vibrational and rotational equilibrium for this case is discussed briefly. A.

541.126

1393. Initiation of explosion in liquids. P. GRAY. *Trans. Faraday Soc.*, **46**, 848–52 (*Oct.*, 1950).

Describes measurements of the transient pressures developed in the trapped gas bubble during impact with an apparatus based on the piezo-electric effect which makes it possible for graphs of pressure against time to be recorded. Its behaviour has been examined with non-explosive liquids; it has been calibrated by a dynamic method and used to investigate liquid explosives. The results obtained show that very high pressures are produced even by light blows; thus in a small trapped bubble temperatures of the order of 1 000°c may be reached. Evidence is presented to support the view that explosion begins as a burning of the explosive vapour present in the gas bubble where, however, its concentration is extremely low. An examination of the ignition of greatly diluted explosive vapours confirms this suggestion. A.

541.127

1394. The thermal decomposition of nitromethane. T. L. COTTRELL AND T. J. REID. Letter in *J. Chem. Phys.*, **18**, 1306 (*Sept.*, 1950).

541.127 : 536.7

1395. Classical thermodynamics and reaction rates close to equilibrium. M. MANES, L. J. E. HOFER AND S. WELLER. *J. Chem. Phys.*, **18**, 1355–61 (*Oct.*, 1950).

For reversible reactions close to equilibrium the net reaction rate $(r_f - r_b)$ is shown to be proportional to ΔX, where X is any one of the thermodynamic functions, e.g., the Gibbs free energy, F, governing equilibrium under the conditions of the reaction, e.g. $(r_f - r_b) = r_f(-\Delta F/RT)$. The derived relationships are independent of the manner in which small displacements from equilibrium may be brought about. Equations are derived by which the magnitude of the forward (or backward) reaction rate at equilibrium may be determined with the aid of observations of the net reaction rate close to equilibrium. Since the magnitude of the former is a function of the kinetics of the reaction, measurements of the net reaction rate near equilibrium over a range of conditions may be used within specified limits to determine the kinetics of reversible reactions. A.

541.127 : 539.155.2

1396. Oxygen and nitrogen isotope effects in the decomposition of ammonium nitrate. L. FRIEDMAN AND J. BIGELEISEN. *J. Chem. Phys.*, **18**, 1325–31 (*Oct.*, 1950).

The isotopic composition of the products of the controlled thermal decomposition of NH_4NO_3 has been studied. It has been found that small amounts of water are necessary to initiate the decomposition. $N^{15}H_4NO_3$ has been found to yield exclusively the isomer $N^{15}N^{14}O$. Some inferences are drawn from this observation regarding the mechanism of the reaction. O and N isotope effects accompanying the decomposition have been studied with material of "natural" isotopic composition. Satisfactory agreement is found between the experimental results and theoretical calculations. A method for the isotopic analysis of nitrates for O^{18} is outlined. A.

541.128.1

1397. The mechanism of ammonia oxidation and certain analogous reactions. J. ZAWADZKI. *Disc. Faraday Soc., No.* 8, 140–52 (1950).

The characteristic feature of the reaction of catalytic ammonia oxidation is its great velocity; in favourable conditions nearly every one of the NH_3 molecules striking the surface of the Pt catalyst gives NO as the final product. The attainment of the high efficiency of the oxidation to the desired product depends on the velocities of a number of successive and simultaneous reactions, which take place in the system NH_3—O_2—catalyst, as well as on the suppressing of the reactions between reagents, intermediate and final products of reaction before and after the catalyst. From experiments on various catalysts (Pt, oxides) under such conditions that N_2O appears as one of the main products a scheme of the most probable mechanism of reaction is given. Certain assumptions are made concerning the elementary processes and the chemisorption of O_2 on the catalyst which proceeds with great velocity. A.

541.128.1

1398. The use of ^{18}O in studies of the reactivity of solid oxides. E. R. S. WINTER. *Disc. Faraday Soc., No.* 8, 231–7 (1950).

An experimental technique is outlined for following continuously with a mass spectrometer O^{18} exchange between solid oxides and O gas. Preliminary results are presented and discussed for Th and chromic oxides. The apparent activation energy for oxygen exchange is $27 \pm 0{\cdot}5$ kcal/mole for ThO_2 between 440° and 540°c. With Cr_2O_3 two processes are operative, one at temperatures below 410°c with an activation energy of $29{\cdot}5 \pm 0{\cdot}5$ kcal/mole and one above 410°c with an activation energy of 1 ± 4 kcal/mole. The high activation energy is ascribed tentatively to a limiting process governed by the rate of desorption of O from the oxide surface. The low activation energy is believed to be associated with the true exchange reaction. The kinetics of these two limiting cases are discussed. A.

541.128.13

1399. The physical properties of promoted molybdenum dioxide catalysts. R. H. GRIFFITH, P. R. CHAPMAN AND P. R. LINDARS. *Disc. Faraday Soc., No.* 8, 258–64 (1950).

The physical properties of MoO_2 catalysts, promoted by the addition of small amounts of silica, have been examined. Great changes in the surface area take place as the silica content increases, but these do not alone account for the differences in the activity for hydrocarbon decomposition. Measurements of the composition, crystal structure, electrical conductivity and thermoelectric potential of the catalysts are also recorded and the results suggest that MoO_2 rather than Mo metal is the catalyst, and that the function of the promoter is to increase the surface of the dioxide. This is effected to the greatest degree when the maximum amount of silica is incorporated into the MoO_2 lattice. A.

541.128.13 : 537.311.33

Electronic conductivity and surface equilibria of zinc oxide. *See Abstr.* 1056

541.128.13 : 537.311.33

1400. Semi-conductivity and catalysis. T. J. GRAY. *Disc. Faraday Soc., No.* 8, 331–7 (1950).

The adsorption and interaction of gases on semi-conductors leads to a variation in semi-conductivity which can be successfully applied to the study of adsorption catalysis. Fundamental information is simultaneously furnished regarding the semi-conductivity process. An experimental technique is described for a study of the adsorption of gases by variation in semi-conductivity. A.

541.128.13 : 537.531 : 535.3

1401. Study of catalysts by scattering of X-rays at small angles. A. GUINIER. *Disc. Faraday Soc., No.* 8, 344–7 (1950).

The possibilities of using small-angle scattering of X-rays for the determination of the degree of dispersion of catalysts are discussed. It is concluded that these measurements cannot alone provide precise information about the different size and shape of an irregular array of particles of a powder catalyst, but in simple cases or when they are supplemented by information obtained by other methods, such as by electron microscopy, the quantitative use of X-ray data is possible. A.

541.128.13 : 537.531 : 535.3 : 537.533.72

1402. Electron microscopy and small angle X-ray scattering. J. TURKEVICH, H. H. HUBBELL AND J. HILLIER. *Disc. Faraday Soc., No.* 8, 348–52 (1950).

The application of the electron microscope to the study of catalytic substances is discussed. The substances commonly used as heterogeneous catalysts reveal under electron microscope examination a diversity of form: amorphous materials, small spherical bodies, fibres and plates. Applications are cited in the use of the electron microscope for the study of catalyst preparation and sintering. The difficulties of this method of the examination of the fine structure are presented. An apparatus for small angle scattering of X-rays for particle size determination is described. Correlations are presented on the particle size determinations by the electron microscope with those obtained from the low angle scattering of X-rays. A.

541.128.13 : 538.214

1403. Structure of oxide catalyst systems. P. W. SELWOOD AND L. LYON. *Disc. Faraday Soc., No.* 8, 322–30 (1950).

Magnetic methods, in general, reveal the oxidation state and the atomic environment of active oxides of the transition group elements. Susceptibility isotherms have been determined for all these elements, and their interpretation falls into three categories: change of exchange interaction, change of oxidation state and interaction covalency. There is no obvious relation between magnetic susceptibility and catalyst activity. The susceptibility is a tool for the elucidation of structure, which in turn determines activity. Nevertheless, it is not infrequently possible to predict catalyst activity from susceptibility measurements, especially when these are considered together with surface area determinations. These methods are applicable not only to supported oxides but to the same oxides in self-supported, or gel-like systems. A.

541.128.13 : 539.152.1

1404. Proton relaxation and catalyst accessibility. P. W. SELWOOD AND F. K. SCHROYER. *Disc. Faraday Soc., No.* 8, 337–44 (1950).

The accessibility of a solid catalyst may be defined as the ratio of activity shown by a fixed weight of solid catalyst to that of the same weight of catalyst in true solution in the reacting medium. This quantity may readily be evaluated by the nuclear induction experiment. The proton relaxation time in water is determined, for example, for supported iron oxide on alumina. Catalyst accessibility is then found by relating the measured relaxation time to that observed in solutions of ferric sulphate in water. The accessibility is further corrected for 180° shielding on the under side of the surface. The accessibility then becomes $a = 2M_0/M$, where M and M_0 are the apparent molar concentrations of promoter in supported form and in true solution respectively. A.

541.128.13 : 539.155.2

1405. Stable and unstable isotopes in catalytic research. J. TURKEVICH, F. BONNER, D. SCHISSLER AND P. IRSA. *Disc. Faraday Soc., No.* 8, 352–6 (1950).

A discussion is given of the advantages and disadvantages of the use of stable and unstable isotopes in catalytic research. The application of radioactive carbon to the study of the reduction of carbon dioxide by carbon is presented. The results of the use of radioactive H for the study of the catalytic double bond migration are cited as evidence for the theory of a H switch mechanism. A discussion is given of the use of D and mass spectrometry to determine the number and position of the D atoms in molecules containing varying amount of the D atoms. This use of the stable isotope of H is illustrated by examples of the analysis of the reaction of C_2H_4 and D on a Ni wire catalyst. A.

541.128.13 : 539.23

1406. On conditions for the existence of surface states. C. A. COULSON AND G. R. BALDOCK. *Disc. Faraday Soc., No.* 8, 27–33 (1950).

The existence or non-existence of surface states on the boundary of a monovalent metal is investigated fully for simple cubic models in 1, 2 and 3 dimensions, using the molecular modification of Bloch wave functions. Limiting values are found for the necessary changes required at the surface atoms, both for their Coulombic (electronegativity) terms α and their resonance integrals β. It is shown that surface states may be induced by the perturbation caused by the approach of a polar, or ionic, group; and that such surface states are more easily produced close together than separately. In certain non-cubic systems, e.g. graphite, surface states exist even without any necessary changes in α or β on the boundary. Finally, a series of recent theorems on the charge distribution in large molecules is applied to a study of the alternating charge distribution sometimes associated with surface states. A.

541.128.13 : 539.234 : 548.5

1407. The effect of crystal parameter on hydrogenation and dehydrogenation. O. BEECK AND A. W. RITCHIE. *Disc. Faraday Soc., No.* 8, 159–66 (1950).

Through measurement of the surface of oriented

and unoriented evaporated porous Ni films by the B.E.T. method, using Ne, Kr, CH_4 and C_4H_{10}, and by measuring the number of crystallographic sites through the adsorption of H at liquid N temperature, direct proof has been obtained that (110) oriented Ni films do also expose (110) planes to the gas phase. A study of the hydrogenation of benzene over oriented and unoriented Ni and Fe films showed no difference in rate in contrast to the previously reported 5-fold rate for the hydrogenation of ethylene over (110) oriented Ni films in comparison to unoriented films. It is concluded that the observed slow hydrogenation, which kinetic considerations show, proceeds through the adsorbed state of benzene, is not influenced by the crystal geometry of the substrate. In contrast, the dehydrogenation of cyclohexane over unoriented Pt, was found to be 10 times faster than over partially (110) oriented Pt films, indicating that the geometrical factor is of great importance in this reaction, the kinetics of which is in agreement with the assumption that cyclohexane loses 6 H atoms simultaneously when colliding with the catalyst surface. A.

541.128.13 : 541.127

1408. Hydrogenation catalysts. O. Beeck. *Disc. Faraday Soc., No.* 8, 118–27 (1950).

The rate of the hydrogenation of ethylene over evaporated porous metal films of the transition elements is strongly depending on the heat of adsorption of ethylene, which (except for much higher absolute values) parallels that of hydrogen. When plotted against the *d*-character of the metallic single bond (Pauling), both the heats of adsorption of ethylene (or hydrogen) and the rates of hydrogenation fall on smooth curves, such that the greater the *d*-character, the lower are the heats of adsorption and the higher the rates. The following mechanism for the hydrogenation is suggested. Depending on the heat of adsorption for ethylene, initial irreversible poisoning by acetylenic adsorption complexes, formed by self-hydrogenation of ethylene, renders the surface more or less inactive for hydrogenation. On the remaining part of the surface the overall rate of reaction is determined by the reaction of adsorbed ethylene (non-dissociative) with adsorbed hydrogen with an apparent activation energy of 10·7 kcal for metals of Group VIII. Strong evidence is presented that a third type of a fast reaction with low activation energy is also involved. A.

541.128.13 : 541.183.02

1409. Behaviour of a molecule near a metal surface. K. Huang and G. Wyllie. *Disc. Faraday Soc., No.* 8, 18–27 (1950).

An account is given of the energy changes associated with electron transfer to or from a molecule at distances from the metal surface such that quantum-mechanical tunnel effect may be neglected. A self-consistent treatment of the image field is used to find the distribution of charge on a large adsorbed molecule. The modification in electronic structure of an adsorbed molecule in consequence of the formation of a weak covalent bond with the metal is treated in terms of a very simple model. A possible semi-empirical approach to treatment of the catalytically active surface is examined. A.

541.128.13 : 541.18

1410. The role of heterogeneity in adsorption a catalysis. G. D. Halsey, Jr. *Disc. Faraday So No.* 8, 54–6 (1950).

Data on adsorption almost always deviate from t Langmuir equation. These deviations often can formally explained equally well by interaction betwe absorbed molecules or non-uniformity of the adsor ing surface. The author has emphasized the seco of these explanations, and a discussion is given various proofs or indications that it is a valid or In some cases, notably physical adsorption near t saturation pressure, interaction plays an importa role in determining the isotherm. The author h shown that a refined treatment of a uniform surfa does not lead to the BET equation but leads to t conclusion that heterogeneity and interaction opera simultaneously. The BET surface area determin tion using N as adsorbate, seems completely sat factory. The reasons that explain this validity in t face of the unreality of the isotherm equation are d cussed. The rate of reaction on a non-unifor catalyst surface is formulated, and it is pointed o that the assumption that some one reaction is t rate-determining step is no longer valid. Because group of sites that are of overwhelming importan catalytically may not contribute appreciably to adsor tion, there is no very direct information about cataly to be gained from adsorption studies. Also, on non-uniform surface, the rate of the forward reacti cannot be determined from the equilibrium consta and the rate of the backward reaction, except equilibrium.

541.128.13 : 541.183

1411. The mechanism and temperature coefficient the para-hydrogen conversion. E. K. Rideal a B. M. W. Trapnell. *Disc. Faraday Soc., No.* 114–18 (1950).

The results of a volumetric study of the chem sorption of H by evaporated W films are summarize These indicate that the probable mechanism of t parahydrogen conversion by W surfaces is the co densation and re-evaporation of chemisorbed g The significance of the temperature coefficient of t conversion rate is discussed.

541.128.13 : 541.183

1412. On the existence of active centres in chemic adsorption and contact catalysis. A. Eucken. *Di Faraday Soc., No.* 8, 128–34 (1950).

The problem as to whether chemisorption a catalytic reaction occur over the whole availab surface of a catalyst or only at active centres is d cussed. The apparent heterogeneity arising fro mutual interaction of adsorbed particles and t possibility of different states of the adsorbate on t surface are considered in detail for the adsorption H on highly activated Ni. It is concluded that t supposed effect of active defects should be rejected a that the essential part is played by the active inte mediate states of the adsorbed reactant.

541.128.13 : 541.183

1413. Reactions on the surface of copper oxid W. E. Garner, T. J. Gray and F. S. Stone. *Dis Faraday Soc., No.* 8, 246–50 (1950).

The adsorption of O_2 increases the semi-condu

tivity λ of the Cu_2O–CuO system, so that measurements of λ can be used to follow reactions occurring on a film of this solid. The adsorption process is probably $O_2(gas) \rightleftharpoons O_2(ads.) \rightarrow O(lattice) + O^*$ where O^* is one member of an ion-pair, with Cu^{++} the other. The processes occurring when CO and CO_2 are separately admitted to an evacuated surface, and an oxygenated surface, respectively, are described. A CO_3 complex appears to be formed as an intermediate.

I. Semi-conductivity measurements. T. J. GRAY AND S. O. SAVAGE. *Ibid.*, 250–4.

Films of copper 500–1 000 Å thick, on glass, were prepared by controlled oxidation. The rate of adsorption of O_2 by the oxide film was followed by measurements of the electrical conductivity; results indicate that the rate-determining step is kinetically first-order; the velocity constant is proportional to p at low p, and approaches a constant value at higher p (p = pressure of oxygen).

II. Surface processes and heats of adsorption. F. S. STONE AND P. F. TILEY. *Ibid.*, 254–8.

The uptake of O_2 by the film follows the law of $p^{\frac{1}{2}} \propto t^{\frac{1}{2}}$; the rate-determining step is probably activated diffusion rather than activated adsorption (t = time). Dissociation $O_2 \rightarrow 2O$ probably occurs on the surface. The uptake of CO and of CO_2 by both the evacuated and the oxygenated film was studied by measurements of pressure and of the heat of adsorption—the latter in a special calorimeter [Garner and Veal, *J. Chem. Soc.*, 1437 (1935)].

S. J. GREGG

541.128.13 : 541.183.2 : 530.162

1414. Statistical aspects of chemisorption. A. R. MILLER. *Disc. Faraday Soc., No.* 8, 57–69 (1950).

The basis of the statistical mechanical account of adsorbed monolayers is discussed, and the way in which the properties of the monolayer can be deduced is indicated. The physical distinction between immobile and mobile monolayers of particles adsorbed on localized or fixed sites is emphasized and important differences in the properties of these two types of films are examined. The way in which the experimental results for adsorption on to clean surfaces can be interpreted in the light of these ideas is described. For O films adsorbed on W it is shown that these ideas lead to a consistent picture of the way in which successive layers of the film can be built up. The application to H films adsorbed on W is also examined. More recent measurements of the variation of the heat of adsorption of these films suggest that the earlier interpretation of them was oversimplified, although the basic ideas are vindicated. It now appears that H films adsorbed on W pass through an intermediate region when the surface is about three-quarters covered, and their behaviour changes from that of an immobile film to that of a mobile film adsorbed on localized sites. A.

541.128.13 : 541.183.2 : 536.66

1415. A calculation of heats of chemisorption. D. D. ELEY. *Disc. Faraday Soc., No.* 8, 34–8 (1950).

Heats of chemisorption are calculated by Pauling's equation for covalent bonds. Quite good agreement is secured for H on W, Cu and Ni. Calculations for O on W and C_2H_4 on Ni enable us to rule out certain mechanisms of chemisorption. A.

541.128.13 : 541.183.2 : 537.221

Studies in contact potentials. I. The adsorption of some gases on evaporated nickel films. *See Abstr.* 1034

541.128.13 : 541.183.2 : 541.124

1416. The activated complex in chemisorption and catalysis. H. EYRING, C. B. COLBURN AND B. J. ZWOLINSKI. *Disc. Faraday Soc., No.* 8, 39–46 (1950).

The basic assumptions underlying the theory of absolute reaction rates have been analysed in terms of recent studies. A general treatment of chemisorption and catalysis is given in terms of the activated complex theory of chemical kinetics. A mechanism is proposed for the hydrogenation of ethylene which appears to be in agreement with the available data. A.

541.128.13 : 541.183.2 : 541.124

1417. The activated complex in heterogeneous catalysis. K. J. LAIDLER. *Disc. Faraday Soc., No.* 8, 47–54 (1950).

The evidence that certain surface reactions proceed by interaction between an adsorbed molecule and a gas-phase molecule is reviewed briefly, with special reference to the para-ortho H conversion and the combination of atoms and free radicals. On the basis of absolute rate theory, general rate expressions are developed for reaction between two molecules A and B, of which A is more strongly adsorbed, assuming the following alternative mechanisms: (1) interaction between adsorbed A and adsorbed B, (2) interaction between adsorbed A and gaseous B, (3) interaction between adsorbed B and gaseous A. The rate expressions are compared with special reference to the reaction between C_2H_4 and H, for which it is shown that the data appear to favour mechanism (1). The low-frequency factor for the reaction ($\sim 10^{-6}$) is explained quantitatively on the basis of the theory, being due to the loss of translational and rotational freedom in forming the activated complex. The close analogy between surface and enzyme reactions is discussed, and it is shown that many enzyme processes can be interpreted on the basis of mechanism (1). A.

541.128.13 : 541.183.2 : 541.124

1418. The kinetics of catalytic reactions on inhomogeneous surfaces. H. DE BRUIJN. *Disc. Faraday Soc., No.* 8, 69–79 (1950).

A theory has been developed for the kinetics of catalytic reactions on inhomogeneous surfaces, starting from an entirely arbitrary distribution of the more or less active sites on the surface. The ammonia synthesis was used as a model process. It was assumed that the adsorption of the velocity-determining reactant (in this case N) is of an atomic character and that an unrestricted migration may occur on the surface. The influence of simultaneous adsorption of the second reactant and the reaction product has been discussed. An essential factor of the theory is the occurrence of a so-called inhomogeneity factor in the reaction-rate relation. The value of this factor is determined by the frequency of those active sites which are really active under synthesis conditions. What active sites (characterized by their heat of adsorption) are really active depends on the temperature, total pressure and gas composition. Particular attention is paid to the influence which the total pressure and the gas composition have upon the

value of the inhomogeneity factor. Thus it was possible to give an explanation for the practical rule for the testing of catalysts used in high pressure synthesis. A.

541.128.13 : 541.41

1419. Catalytic activity and composition of oxide systems. G. F. Hüttig. *Disc. Faraday Soc.*, *No.* 8, 215–22 (1950).

Intermediate states in the transformation from an oxide mixture to a chemical compound are important in the theory of catalysts. The transformation does not proceed discontinuously but through individual characteristic states; it takes place by the diffusion of the mobile component, i.e. the oxide of lower melting point, over the surface of the less mobile component, the former later becoming strongly bound and localized. Other stages of activation include internal diffusion of the mobile oxide, the formation of disordered crystalline aggregates and finally the filling of crystal defects. The various stages are linked with the changes of catalytic activity during activation for binary oxide systems. A.

541.128.13 : 548.734.842

1420. Alloy catalysts in dehydrogenation. G. M. Schwab. *Disc. Faraday Soc.*, *No.* 8, 166–71 (1950).

In homogeneous Hume–Rothery alloys the activation energy of the formic acid dehydrogenation increases in proportion to the square of the increase of the electron concentration caused by the multivalent solute metal. Amongst the intermetallic Hume–Rothery phases, the γ-phase shows a maximum activation energy. In general, activation energy and electric resistance run parallel. It is concluded that the catalytic activation consists in an entrance of substrate electrons into empty levels of the first Brillouin zone of the metal. It is suggested that in alloys containing polar or covalent bonds the conductivity electron concentration is lowered. Catalytic experience confirms this view. The frequency factors of the dehydrogenation reaction on different catalysts increase logarithmically with increasing activation energy. The mechanical hardness of alloys runs parallel with the activation energy, and it is concluded that the hardness is a function of the saturation of the Brillouin zone. This is confirmed catalytically for martensite. A.

541.128.13 : 548.734.842

1421. The parahydrogen conversion on palladium–gold alloys. A. Couper and D. D. Eley. *Disc. Faraday Soc.*, *No.* 8, 172–84 (1950).

The activation energy of the parahydrogen conversion on Pa-rich alloys is 3·5 kcal/mole and increases abruptly between 40 and 30 atomic % Pa to the value of 8·5 kcal found for Au-rich alloys. Magnetic measurements have identified this composition as corresponding to the complete filling of the *d*-band, or atomic *d*-orbitals, with electrons. Vacant *d*-orbitals are therefore essential for the low-temperature catalysis, and it is suggested that they bond the chemisorbed H atoms M—H. The reaction goes through a triatomic H_3 complex formed by entry of an H_2 molecule from the van der Waals layer. It is postulated that each site exerts two bonds to the activated complex, employing "atomic" *d* and hybrid $d^{2\cdot56}\,sp^{2\cdot22}$ metallic orbitals. The values of temperature-independent factor found agree with earlier calculations for this mechanism. The *d*-band of Pa may also be filled by electrons from dissolved H atoms which cause a similar increase in activation energy. A.

541.128.13 : 548.734.842

1422. Some reactions over alloy catalysts. D. A. Dowden and P. W. Reynolds. *Disc. Faraday Soc.*, *No.* 8, 184–90 (1950).

Analysis of the "electronic factor" in heterogeneous catalysis suggests that activity of Ni–Fe alloys in multiple bond hydrogenation should increase rapidly in the region where the energy density of electron levels at the Fermi surface rises; moreover, that reactions controlled by the rate of transfer of an electron from metal to substrate should, in the Ni–Cu alloys, decrease in rate as the 3*d*-band begins to empty. Experiments on styrene hydrogenation over Ni–Fe catalysts and H_2O_2 decomposition on Ni–Cu alloy foils provide general confirmation of these predictions. Methanol and formic acid decompositions on the Ni–Cu alloys decrease in speed as the 3*d*-band holes are filled, following the pattern of multiple bond hydrogenation over supported Ni–Cu catalysts and further emphasize the role of the electronic factor in catalysis. A.

541.128.3

1423. The mechanism of the catalytic hydrogenation of ethylene. G. H. Twigg. *Disc. Faraday Soc.*, *No.* 8, 152–9 (1950).

Ethylene has been hydrogenated on a Ni catalyst at -78°C with (*a*) a mixture of $H_2 + D_2$, and (*b*) the equilibrium mixture of $H_2 + HD + D_2$. Infrared spectroscopic examination showed that the mixtures of ethanes produced in the two experiments were identical, and were different from an equimolar mixture of C_2H_6 and $C_2H_4D_2$. This is direct proof that in hydrogenation the H is first dissociated into atoms on the catalyst. This result and the existing knowledge concerning the hydrogenation and exchange reactions are reviewed, and a mechanism for hydrogenation is proposed which accounts for all the known facts, and in particular for the temperature dependence of the energy of activation. A.

541.128.5

1424. The relationship between sensitivity to poisoning and catalytic surface. E. B. Maxted, K. L. Moon and E. Overgage. *Disc. Faraday Soc.*, *No.* 8, 135–40 (1950).

The expected inverse variation of sensitivity to catalyst poisoning with the surface area of a catalyst has been confirmed experimentally for Pt hydrogenation catalysts poisoned with methyl sulphide, a relationship of the type: $\alpha_1 s_1 = \alpha_2 s_2$, in which α is a measure of the sensitivity and s is a measure of the surface area, being obtained. This relationship apparently holds even when the variation in the area of a constant weight of Pt is induced by sintering. A characteristic value for the product αs has been obtained which should make possible the calculation of the surface area of Pt catalysts in general by sensitivity tests carried out on small quantities of Pt. A.

ELECTROCHEMISTRY 541.13

541.135.2

1425. Considerations on ionic elevation of fluidity and ionic mobility. T. WATARI. *Bull. Tokyo Inst. Techn. B* (*No.* 2) 43 *pp* (1950).

The frequency, k', of transition of a H_2O molecule from one equilibrium state to the next when it is in the neighbourhood of an ion was calculated by using an extension of Eyring's formula for liquid flow. The change in fluidity of the co-ordination sphere of an ion was thus obtained. The elevation of fluidity due to some ions, e.g., Cs^+, Rb^+, I^- and Br^- can be explained by the fact that k' for them is higher than it is in pure H_2O. By applying the Zwicky formula to the calculation of the change of fluidity in the bulk of the solution arising from pressure change or electrostriction due to the ionic charge, the equivalent ionic elevation of fluidity was calculated. The results are in agreement with experiment. The method was extended to the determination of ionic mobility. It is proposed to subdivide the total ionic mobility into two parts which correspond to the mobility of the naked ion through its co-ordination sphere, and that of the latter through the adjacent sphere. The value of k' for a H_2O molecule in each sphere is calculated and the combined values agree satisfactorily with the observed values of the total ionic mobility. The relationship between the fluidity of an electrolyte solution and ionic mobility is discussed. The temp. coefficient, f, of ionic mobility is calculated. The difference between calculated and experimental values of f is almost constant within a series of ions of similar type, e.g. alkali metal ions or halogen ions. The formula for k' of a H_2O molecule in the neighbourhood of an ion is examined in the light of this constant difference of f values. The apparent hydration number of migrating ions is calculated, the results agreeing satisfactorily with experiment.

A. J. MEE

541.135.2

1426. State of solvation of ions in liquid mixtures. G. KORTÜM AND A. WELLER. *Z. Naturforsch.*, **5a**, 451–6 (*Aug.*, 1950) *In German.*

Experimental details with tables and curves are recorded for conductivity measurements of lithium picrate in water-ethanol mixtures with respect to salt concentration and mol.-fraction of the solvent. The extrapolated values for the equivalent conductivities at infinite dilution show appreciable deviation from those calculated from the Onsager equation even for mixtures of high water content, and this is ascribed to selective solvation by the ions. The structure of such water-ethanol mixtures is discussed with respect to the invalidity of the Walden rule. H. H. HODGSON

541.135.5

1427. Determination of the capacity of the double electrical layers of a mercury jet electrode. III. Determination of the maximum electrocapillaries and capacitance of the double electrical layer in solutions containing no oxygen. A. RÍUS AND A. MARÍN. *An. Real Soc. Esp. Fis. y Quim.*, **46A**, 239–50 (*Sept.–Oct.*, 1950) *In Spanish.*

See Abstr. 8291–2 (1950) for parts I and II. A technique is described that permits of measuring with the jet electrode the above quantities in oxygen-free concentrations down to 1/1 000 M. The error is always $< \pm 2\,\mu F$. The values are in accord with results from other methods and with those of the electrocapillary method. The potential of the electrocapillaries can be determined under the above conditions to an error of $< \pm 5$ mV. W. SUMMER

541.135.5

1428. The electrochemical behaviour of the antimony electrode. S. E. S. EL WAKKAD. *J. Chem. Soc.*, 2894–9 (*Oct.*, 1950).

From the discrepancies in the reports on the behaviour of the Sb electrode, it is evident that this depends on the prevailing conditions. Recently, the electrode was regarded as irreversible, its potential being governed by an O overvoltage, and it has been called a metal–metal oxide–O electrode. It is now shown that the irregularities are caused by the gradual formation of a higher oxide (tetroxide) on the electrode and by its exceedingly slow attainment of equilibrium, which depends upon the supply of O as well as on the surface of the metal exposed. The Sb electrode is shown to be a true metal–metal oxide electrode provided that the measurements recorded represent true equilibrium values. A.

541.135.5

1429. The anodic behaviour of metals. VI. Cobalt. S. E. S. EL WAKKAD AND A. HICKLING. *Trans Faraday Soc.*, **46**, 820–4 (*Oct.*, 1950).

The initial build-up of anodic polarization at a Co anode over a wide range of conditions has been investigated using the cathode-ray oscillograph. In alkaline solutions 3 stages of oxidation have been distinguished corresponding to the formation of CoO, Co_2O_3 and CoO_2. In general it appears that CoO is first formed but this is further oxidized to Co_2O_3 when the surface is only partly covered with the lower oxide. In hot concentrated alkali solutions continuous dissolution of CoO to give cobaltite ions may occur. In the passivation of a Co anode the Co_2O_3 forms a protective layer, essentially 1 molecule thick, which is further oxidized to CoO_2 before O evolution commences. From the present work the standard Co_2O_3/CoO_2 potential is $+ 0{\cdot}58$ V. A.

541.135.5 : 621.357 : 621.316.722.1

1430. A device for maintaining a constant potential for electro-chemical work. F. W. CHAMBERS. *J. Sci. Instrum.*, **27**, 292–4 (*Nov.*, 1950).

An apparatus is described which can be used to control accurately the potential of either working electrode during a number of electrolytic operations, such as the cathode potential during the fractional electro-deposition of metals from their mixed solutions. The apparatus is self-contained, compact and easily constructed. It is sensitive to at least ± 5 mV over a current range of 500 : 1 on the working electrodes and imposes a maximum load of only 10^{-8} A on the reference cell. A circuit for the simultaneous control of several cells is indicated. A.

541.135.7

1431. Making small metal tubes by electrodeposition on nylon fibers. R. J. E. GEZELIUS. Note in *Rev. Sci. Instrum.*, **21**, 886 (*Oct.*, 1950).

541.135.7 : 621.317.35 : 621.357.1.025

1432. Studies on alternating current electrolysis. II. Oscillographic studies. J. SILVERMAN AND A. E. REMICK. *J. Electrochem. Soc.*, **97**, 335–45 (*Oct.*, 1950).

Reichenstein's oscillographic study of the a.c. electrolysis of aqueous H_2SO_4 was repeated. His contention that the instantaneous value of the cell voltage at zero instantaneous current, corrected for R drop, approaches a limiting maximum value as the r.m.s. value of the current increases was found to be true; but his statement that this max. voltage is the thermodynamic decomposition potential of water was not verified. Actually, it turns out that this voltage includes the associated overvoltage. Oscillographic studies were also made on two reversible redox systems. Variations produced by changes in c.d., concentration, frequency, and redox ratio were explained in terms of a qualitative theory. A.

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14

541.14

1433. Photo-oxidation of water by ceric ions. M. G. EVANS AND N. URI. Letter in *Nature, Lond.*, **166**, 602–3 (*Oct.* 7, 1950).

A reaction scheme for the photo-oxidation of H_2O by ceric ions is proposed as follows: (1) $Ce^{4+}OH^- \rightleftharpoons Ce^{3+}OH$; (2) $Ce^{3+}OH \rightarrow Ce^{3+} + OH$; (3) $Ce^{3+} + OH \rightarrow Ce^{4+} + OH^-$; (4) $Ce^{4+}OH^- + OH \rightarrow Ce^{3+} + H_2O_2$; (5) $2Ce^{4+}OH^- + H_2O_2 \rightarrow 2HOH + 2Ce^{3+} + O_2$. The kinetics of these reactions are considered. The max. quantum yield is about 5×10^{-2}. A. J. MEE

541.14 :.537.531

1434. Chemical action of ionizing radiations on nucleic acids in aqueous systems. G. SCHOLES AND J. WEISS. *Nature, Lond.*, **166**, 640–2 (*Oct.* 14, 1950).

Aqueous solutions of yeast ribonucleic acid and of thymus deoxyribonucleic acid were irradiated with X-ray doses up to 90 000 r and chemical analyses were made for ammonia and inorganic phosphate. The results indicate that the degradation of nucleic acids by X-rays is of a chemical nature and that under suitable conditions OH radicals and H atoms, formed from the water solvent, are both effective.

C. B. ALLSOPP

541.141.5

1435. Energy transfers between active nitrogen and sodium, potassium and antimony. A. FINKELSTEIN. *C.R. Acad. Sci., Paris*, **231**, 341–2 (*July* 31, 1950) *In French.*

The decomposition of AgN_3 in a vacuum in the presence of vapours of alkali metals gives rise to the reappearance of u.v. emission. In the case of Na vapour (pressure 10^{-2} mm) the emission is 4–12 times greater than without Na. A decrease of emission was observed in the presence of K vapour (pressure 0·1 mm at 272°c). Emission by AgN_3 was completely quenched in the presence of 200 mg of Sb, while in the presence of 2 mg of Sb the emission was 3 times greater than for pure N. F. LACHMAN

DISPERSIONS . COLLOIDS. ADSORPTION 541.18

541.18 : 534.321

1436. The effect of ultrasonic irradiation on t formation of colloidal sulphur and ice. C. F. TURN AND A. VAN HOOK. *J. Coll. Sci.*, **5**, 315–16 (*Au* 1950).

Nucleation of systems unaffected or inhibited h.f. ultrasonic irradiation is intensified by l.f. sou waves of sufficient power. The tests proving this we made with S dispersed in HCl and $Na_2S_2O_3$ respe tively and with ice crystals in supercooled wat The strong inhibiting effect of nitrite ions in the S s is shown in a table. But even the most strong inhibited solutions coagulate immediately at 8 kc.

R. NEUMAN

541.18 : 532

1437. Viscosity, sedimentation, and diffusion of lon chain molecules in solution as determined by exper ments on large-scale models. H. KUHN. *J. Coll. Sc* **5**, 331–48 (*Aug.*, 1950).

From the hypothesis that long-chain molecules a suitable solvent behave as loose coils the hamper flow and free draining through the coil with respect the hydrodynamical behaviour of the coil are d cussed. Hydrodynamical properties depend chie on the volume of the coil and equations have be derived for the end-to-end distance and the extern dimensions. Correlation is obtained between t molecular coil and large-scale models (constructed bending wire in a statistical manner) through t concept of the preferential statistical elements. means of these models the forces on the long-cha molecules when in translational and rotational moti are discussed, the frictional forces, the constants sedimentation and diffusion, and the intrinsic viscosi being investigated. The ascertained data support t view that hydrodynamics can be applied to examin tion of the behaviour of randomly-coiled, long-cha molecules in solution. W. R. ANG

541.18 : 535.

1438. Spherulitic sectors. J. F. HUTTON. Letter *Nature, Lond.*, **166**, 564–5 (*Sept.* 30, 1950).

Incompletely formed spherulites were observed a dispersion of Na soap in an acid-refined petroleu oil. These sectors of spherulites appeared when t dispersion was cooled slowly (1°c per min) from 200° They have similar optical properties to comple spherulites. J. IBA

541.18 : 535.

1439. Extinction angles, intrinsic viscosities, a molecular weights of polystyrene in solution. M. SCHOENBERG, J. RISEMAN AND F. R. EIRICH. *J. Co Sci.*, **5**, 393–403 (*Aug.*, 1950).

Measurements on sedimentation, intrinsic viscosi and streaming birefringence have been made and a used to show that Kuhn's theory of streaming bir fringence is not adequate. By the introduction of a empirical equation for the extinction angle, analogo to that accepted for rigid particles, the Kirkwoo Riseman theory has been extended to obtain relationship between the molecular weight, t extinction angle and the intrinsic viscosity. T

molecular weights of polystyrene fractions in toluene and in chloroform, calculated from this new relationship, are in good agreement with values derived from established techniques and show that the streaming birefringence method can give valuable data on molecular weights. Values of intrinsic viscosity and rotatory diffusion constant have been deduced from extinction angle measurements. The basic hydrodynamic parameters, b and ζ, of the Kirkwood–Riseman theory have been calculated and are used to determine the average lengths of the molecules and the sedimentation constants. These values are in good agreement with those obtained from light scattering, viscosity, and sedimentation. Similar values computed from Kuhn's treatment are appreciably lower. W. R. ANGUS

541.182.3

1440. Influence of temperature on the micellary size of salt aerosols. L. DAUTREBANDE. *Nature, Lond.*, **166**, 546–7 (*Sept.* 30, 1950).

The particle size and extent of aggregation are increased by cooling. Possible applications are considered. R. F. BARROW

541.182.4 : 532.5

1441. The formation and flow of emulsion. E. G. RICHARDSON. *J. Coll. Sci.*, **5**, 404–13 (*Aug.*, 1950).

541.182.5

1442. The time of setting of gels formed by the mutual interaction of oppositely charged sols at different temperatures. M. PRASAD AND B. N. CHHAYA. *Proc. Indian Acad. Sci. A*, **32**, 74–84 (*Aug.*, 1950).

Gels have been obtained by mixing (i) the positively charged aluminium hydroxide sol (dialysed and undialysed) with negatively charged sols of antimony sulphide, silicic acid and manganese dioxide; and (ii) the negatively charged nickel hydroxide sol dialysed to different extent with the positively charged sol of silicic acid. The time of setting (t) of these gels decreases as increasing volumes (a) of a sol are added to the same amount of the oppositely charged sol. The relation $t = \mathrm{Ra}^{-m}$ and Hurd and Letteron's relation $d\ln t/dT = Q/RT^2$ are obeyed in most cases. Study of the cataphoretic speed and the effect of dialysis on the time of setting support the view that the mutual coagulation of oppositely charged sols of aluminium hydroxide and (i) antimony sulphide and (ii) silicic acid is brought about mostly by the neutralization of the opposite electric charges, though the other gels studied in this paper do not support this view. A.

541.182.6

1443. Stabilization of carbon-black dispersions in hydrocarbons. M. VAN DER WAARDEN. *J. Coll. Sci.*, **5**, 317–25 (*Aug.*, 1950).

Stabilization is effected by aromatic hydrocarbons with sufficiently long aliphatic chains, the activity increasing with the length of chain and with the number of chains per molecule. R. F. BARROW

541.182.6 : 537.36

1444. The concept of critical zeta potential for hydrophobic sols. I. H. B. WEISER AND P. MERRIFIELD. *J. Phys. Coll. Chem.*, **54**, 990–8 (*Oct.*, 1950).

Sols have given inconsistent critical ζ-potential values when coagulated with uni-univalent salts. The abnormal behaviour is attributed to the polydisperse character of the sol investigated. Monodisperse sols of Au and Se were prepared and their mobilities were measured in a modified Burton U-tube by the microscopic moving boundary method. The calculated critical ζ-potential values of the monodisperse sols were constant irrespective of the electrolyte used. With sols of uniform particle size there is no anomalous behaviour of the critical ζ-potential values with uni-univalent electrolytes. A return to the concept of the ζ-potential given by the Helmholtz–Smoluchowski equation as the stabilizing factor of lyophobic colloids is advocated. A.

541.183

1445. Theory of sorption columns. The Ψ conditions: two types of non-equilibrium fronts. L. G. SILLÉN. *Nature, Lond.*, **166**, 722–3 (*Oct.* 28, 1950).

The Ψ conditions for the process in a sorption column are obtained, and applied to two types of non-equilibrium fronts, viz. final form fronts and broadening fronts, after consideration of the corresponding equilibrium process. For ordinary sorption processes, it is shown that results calculated for a linear isotherm will disagree with what is observed in almost all types of experimental sorption or desorption runs. The new approach gives a uniform, rapid and simple way of treating and understanding the processes. H. H. HODGSON

541.183

1446. Theory of sorption columns. Kinetics and equilibria of ion exchange. E. EKEDAHL, E. HÖGFELDT AND L. G. SILLÉN. *Nature, Lond.*, **166**, 723–4 (*Oct.* 28, 1950).

From the graph of the apparent equilibrium const. K of ion exchange, $\mathrm{Ag^+ + HR \rightleftharpoons H^+ + AgR}$, plotted as a function of β, the "silver fraction" in the ion exchanged, it is concluded: (1) that at the lowest velocities of flow the adsorption isotherm, or the equivalent $K(\beta)$, can be obtained from dynamic experiments with the aid of the formula, $\beta = 1 - \int_{\alpha}^{i} \psi d\alpha$, with no less accuracy than from static measurements which are much more laborious; and (2) that the curves of the apparent $K(\beta)$ are a very compact way of representing the whole course of the elution curve. H. H. HODGSON

541.183

1447. On filtration through a sorbent layer. IV. The Ψ condition, a simple approach to the theory of sorption columns. L. G. SILLÉN. *Ark. Kemi*, **2**, *Paper* 34, 477–98 (1950).

See Abstr. 441–2 (1947) for parts I–II; Abstr. 767 (1948) for part III. Ψ for a given layer I is defined as $\Psi = V/x$ (x = distance from beginning (B) of column, V is the volume of solution between I and B. The Ψ-condition is said to hold when c_i and q_i can be expressed as functions of Ψ, i.e. when the boundary conditions contain Ψ as the only variable, and not V or x separately; equilibrium is assumed everywhere between solution and solvent. (c_i millimol/l is the concentration of a solute A_i in the solution at a given point (x, V); q_i millimol is the amount of solute A_i sorbed per cm of sorbent.) Equations are derived which enable the shape of the fronts to be calculated. Special cases considered are: the desorption, and the

sorption, of a single solute; the sorption of several solutes (frontal analysis); exchange sorption (ion exchange), including the displacement of a mixture of ions. S. J. GREGG

541.183

1448. On filtration through a sorbent layer. V. "Final form" fronts and broadening fronts. L. G. SILLÉN. *Ark. Kemi*, **2**, *Paper* 35, 499–512 (1950).

The methods of part IV for equilibrium (*E*) (see preceding Abstr.) are adapted to the conditions of non-equilibrium (*N*). A system which would give a sharp front with *E* gives a front of "final form" with *N*, i.e. a form which moves through the column with the same speed as the *E* front would have had; otherwise a broadening front is obtained. The shape of the final form front is worked out for ordinary sorption and for ion exchange, including displacement separation; and for broadening fronts it is shown how to calculate the sorption isotherm from measurements on the eluate at low velocities of flow. Doubt is expressed as to the validity of the analogies with heat flow and with distillation. S. J. GREGG

541.183 : 536.658

1449. Determination of heats of adsorption using metal films. O. BEECK, W. A. COLE AND A. WHEELER. *Disc. Faraday Soc., No.* 8, 314–21 (1950).

A calorimeter is described suitable for the determination of heats of adsorption of gases and vapours on evaporated porous metal films. The heats of adsorption of hydrogen as a function of fraction of surface covered are given for Ni and Fe films at room temperature and at liquid air temperature. A criterion for mobility of the adsorbed layer is presented and the value of heat of adsorption measurements in the study of catalysis is discussed. A.

541.183.02 : 548.572

1450. Influence of crystal structure on the adsorption of foreign molecules. R. SUHRMANN. *Naturwissenschaften*, **37** (*No.* 14) 329–33 (1950) *In German.*

A review of various methods, mainly electron-optical, using an emission microscope, for examining surfaces of crystalline material when they are exposed to gases or vapours of other substances. Illustrations of many of the effects are reproduced from the literature and the results are discussed in relation to adsorption on different crystal planes. It is shown that such methods of studying adsorption phenomena can be useful in interpreting certain aspects of crystal structure. J. IBALL

541.183.2

1451. Adsorption of carbon dioxide on reduced nickel. T. KWAN. Letter in *J. Chem. Phys.*, **18**, 1309–10 (*Sept.*, 1950).

541.183.2 : 539.234

1452. The adsorption of gases on copper films. J. A. ALLEN AND J. W. MITCHELL. *Disc. Faraday Soc., No.* 8, 309–14 (1950).

A simple experimental technique for investigating the adsorption of gases on evaporated metal films is described. Troublesome dead space corrections have been eliminated and the method of preparation ensures that the free surface of the film will be initially uncontaminated by adsorbed gas layers. The results of an investigation of adsorption and subsequent reaction of O with Cu films in the temperature range from — 183°c to 74°c are presented, and the adsorptive properties of the films at low temperatures and their behaviour at the higher temperatures are shown to be strongly dependent on the thermal history of the films. A.

541.183.3

1453. Use of radiotracers to measure surface adsorption from mixtures. C. M. JUDSON, A. A. ARGYLE, D. J. SALLEY AND J. K. DIXON. Letter in *J. Chem. Phys.*, **18**, 1302 (*Sept.*, 1950).

541.183.35 : 532.516

1454. The surface properties of polar silicones. M. J. NEWING. *Trans Faraday Soc.*, **46**, 755–62 (*Sept.*, 1950).

The investigation has been made with particular reference to orientation on a water surface and efficiency as boundary lubricants. The results show that at low pressure all the silicone molecules are lying flat on the water surface. At a pressure of 8–10 dynes cm^{-1} collapse occurs, and the siloxane chain lifts out of the water. With the hydroxyl compounds the molecule is anchored by the —OH group. Close packing of the molecules does not occur even under a pressure of 25 dynes cm^{-1} because of the small lateral adhesion between the siloxane chains. Behaviour as boundary lubricants on steel is discussed in relation to the possible orientation of the monolayers on the metal surface. Silicones are less effective than polar hydrocarbons in reducing metallic contact. A.

541.183.36 : 532.6

1455. Adsorption of insoluble vapours on a water surface. R. H. OTTEWILL AND D. C. JONES. *Nature, Lond.*, **166**, 687–8 (*Oct.* 21, 1950).

A dipping plate method is described for the measurement of the amount Γ of a vapour adsorbed per cm^2 of a water surface, when the latter is exposed to a series of pressures p of the vapour. The curve of Γ against p for hexane vapour at 0°, 7·5° and 15°c is similar to Brunauer's Type III adsorption isotherm for gas-solid adsorption; it may denote either that the adsorption of the hexane reaches several molecular layers thickness, or that the adsorption of the hexane is confined to a monolayer in the "gaseous" condition, with strong mutual attractions between the molecules. S. J. GREGG

541.183.56 : 536.628.2

The measurement of the thermal properties of gases and vapours adsorbed on solid surfaces. *See Abstr.* 1024

CHEMICAL STRUCTURE 541.4/.6

541.451

1456. The decomposition of lead peroxide and oxidation products of lead oxide. A. BYSTRÖM. *Ark. Kemi Min. Geol.*, **20A**, *Paper* 11, 31 *pp.* (1945).

See also Abstr. 1499 (1951).

541.54

1457. Possible *f*-shell covalency in the actinide elements. L. I. KATZIN; E. GLUECKAUF AND H. A. C. MCKAY. *Nature, Lond.*, **166**, 605–6 (*Oct.* 7, 1950).

The suggestion of Glueckauf and McKay [*Nature*,

Lond., **165**, 594 (*April* 15, 1950)] that the co-ordination of nitrate groups and the extraction of uranyl, neptunyl and plutonyl nitrates into organic solvents are indicative of possible *f*-shell covalency, is opposed by Kratzen, who summarizes evidence for his viewpoint that the co-ordination of nitrate by uranyl ion is neither unique nor different in kind from that found lower in the Periodic Table, and in particular with a transition element such as Co. In reply, the first-named re-affirm their original suggestion that *f*-shell covalency is a possibility. H. H. HODGSON

541.63

1458. On the stereochemistry of lead and some metals with similar atomic structure. A. BYSTRÖM. *Ark. Kemi Min. Geol.*, **25A**, *Paper* 13, 26 *pp.* (1947).

See also Abstr. 1499 (1951).

541.64 : 539.152.2

1459. Study of high polymers by nuclear magnetism. I. Line widths at room temperature. L. V. HOLROYD, B. A. MROWCA AND E. GUTH. Letter in *Phys. Rev.*, **79**, 1026 (*Sept.* 15, 1950).

The field was $\sim 7\,000$ gauss. The line width due to inhomogeneity was 0·19 gauss. For natural rubber the width was $< 0{\cdot}19$; for butyl rubber, 0·38; for polyethylene, 0·57; for *S*-polymers (isobutylene–styrene co-polymers) it ranged from 1·2 to 5·8, increasing with styrene content. The small value for natural rubber is a direct proof of the "free" rotation in this substance of molecules containing proton groups. L. PINCHERLE

541.64 : 539.152.2

1460. Study of high polymers by nuclear magnetism. II. Line width through transition temperatures. B. A. MROWCA, L. V. HOLROYD AND E. GUTH. Letter in *Phys. Rev.*, **79**, 1026–7 (*Sept.* 15, 1950).

In the region in which the polymers change, with decreasing temperature, from a soft rubbery state to a hard glassy state, the line width increases. This may be attributed to crystallization which suppresses the rotation of molecular groups in a major fraction of the material. A tentative explanation is given of all the details of the experimental curves.

L. PINCHERLE

541.64 : 541.124

1461. On the growth and properties of the cuprene fiber. J. H. L. WATSON, A. E. LÉGER AND C. OUELLET. *J. Phys. Coll. Chem.*, **54**, 969–78 (*Oct.*, 1950).

Cuprene polymers prepared by seeding and at a series of temperatures have been examined by the methods of electron microscopy and X-ray diffraction and the observations discussed with reference to certain studies made on the kinetics of the reactions. It is found that Cu is present in relatively large amounts in all of the samples and that cuprite (Cu_2O) is present, at least in the original samples, in trace amounts. These facts, plus the processes of the seeding, confirm that Cu and probably some cuprite are carried along as the fibre grows. This could account for the success of the seeding operation, and it indicates that the fibre grows from its tip rather than from its base. When cuprite is used as a catalyst, the reduction of the oxide to free Cu is a first reaction, probably incident to the growth. Effects of seeding on the morphology of the fibres are discussed. A.

541.64 : 541.133.1

1462. The electrolytic transference properties of polymeric acids. F. T. WALL, G. S. STENT AND J. J. ONDREJCIN. *J. Phys. Coll. Chem.*, **54**, 979–90 (*Oct.*, 1950).

A simple theory is developed for the electrical transference properties of polymeric ions, using Debye's model of a polymer molecule as a string of beads. It is also shown theoretically that electrolytic fractionation can be expected when the degrees of ionization of the polymers in the mixture are different. Experiments have been carried out on three samples of polyacrylic acid and on the hydrolyzed copolymer of maleic anhydride with styrene. The results are in qualitative agreement with the theory. It is found that the transference numbers of polymeric anions are in the neighbourhood of a few hundredths and also that electrolytic fractionation is possible. A.

541.651

1463. Color of diketo–pyrazolidine derivatives. S. IMANISHI. Letter in *J. Chem. Phys.*, **18**, 1307–8 (*Sept.*, 1950).

LABORATORY APPARATUS 542.1/.7

542.2 : 531.752 : 535.214.4 : 621.389

1464. Rectified radio-frequency applications. G. G. BLAKE. Letter in *Aust. J. Sci.*, **11**, 138–9 (*Feb.* 21, 1949).

Describes and illustrates the application of the author's rectified r.-f. circuit for: (*a*) a simple chemical balance; (*b*) a standard chemical balance, the movements of the balance pointer being reproduced as galvanometer deflections; (*c*) displacing the optical lever system of the author's ebonite radiometer (in the latter case the differential rectified r.-f. circuit is used). F. LACHMAN

CHEMICAL ANALYSIS 543/545

545.3 : 541.18

1465. Determination and significance of polarographic critical micelle concentrations. E. L. COLICHMAN. *J. Amer. Chem. Soc.*, **72**, 4036–42 (*Sept.*, 1950).

The critical concentration is shown to be identical with the concentration necessary to suppress maxima (M.S.P.). The great adsorptivity of the colloidal agents at concentrations corresponding to their M.S.P. values seems to account for the ability to suppress maxima by displacing the less actively adsorbed non-surface-active ions from the mercury drop surface. Concentrations of maxima suppressors $>$ the M.S.P. values can influence polarographic properties. Specific influences have been noted and discussed. A.

545.372

1466. The use of the stationary platinum microelectrode in the determination of half-wave potentials. D. B. JULIAN AND W. R. RUBY. *J. Amer. Chem. Soc.*, **72**, 4719–24 (*Oct.*, 1950).

An application of stationary microelectrodes of Pt to the polarographic determination of half-wave

potentials has been described. Examples of the anodic oxidation of several phenylenediamines have been given to illustrate the usefulness of the method. The application of the potentials obtained to studies of the effects of variations in the structure of developing agents has been illustrated. A.

545.38 : 621.314.6 : 621.3.018.78

1467. Distortion of rectified radio-frequency graphs. G. G. BLAKE. *Aust. J. Sci.*, **12** 32–4 (*Aug.*, 1949).

Explains the appearance of curved HCl/NaOH titration graphs in conductimetric tubes employed recently in Australia for analysis and titration by rectified r.-f. current, as due to incorrect rectification, and gives a method of avoiding the distortion.

F. LACHMAN

545.8 : 539.16.08

1468. Estimation of radioactive hydrogen (tritium). D. F. WHITE, I. G. CAMPBELL AND P. R. PAYNE. *Nature, Lond.*, **166**, 628–30 (*Oct.* 14, 1950).

The known ease of deuteration of many organic compounds, and the similar exchange characteristics of tritium, suggest the latter will be a valuable biological tracer, since it is detectable in much greater dilution than deuterium. Tritium cannot be estimated satisfactorily either as water vapour or hydrogen added to suitable counter gases, or as hydrogen with ionization chambers. Methane, produced by the reaction of tritiated water with aluminium carbide at 100°c, is a good counter gas, does not contaminate apparatus, and is used here for tritium estimation. The reaction takes place in a "Pyrex" tube connected through a pumping system to the Geiger counter (a 200 ml glass type with carbon cathode). The proportional region is investigated at various pressures, the optimum being 20 cm Hg (plateau of 200 V, slope 0·3% per volt) 9·4 mgm of methane hydrogen are then present. A comparative assay of the hydrogen from complete reduction of tritiated water, showed that approximately 50% of the available tritium passes into methane in the reaction with aluminium carbide. Assay of material of specific activity $1{\cdot}5\times10^{-6}$ μC per mgm hydrogen is possible. Reproducibility of readings, with methane at 20 cm Hg pressure, is 2–3%. D. V. MABBS

545.82

1469. Technique for the use of an electrode with carbon being used as the reference element in the spectral analysis of solutions. I. A. S. BRETÓN. *An. Real Soc. Esp. Fis. y Quim.*, **46A**, 283–92 (*Sept.–Oct.*, 1950) *In Spanish.*

The carbon line 2478·6 Å is selected as reference standard in the spectral analysis of solutions (tim of exposure, 1 min; electrical pressure, 12 kV). Th effects of variations in capacity, voltage, and tim are discussed. A Hilger E-1 spectrograph wit quartz optic has been used. The diameter of th electrodes was 4·5 mm and the distance of tig 1·5 mm. W. SUMME

545.8

1470. Technique for the use of an electrode wit carbon being used as the reference element in th spectral analysis of solutions. II. A. S. BRETÓ *An. Real Soc. Esp. Fis. y Quim.*, **46A**, 292–30 (*Sept.–Oct.*, 1950) *In Spanish.*

Solutions (0·01 cc) of Mn, Ni, Zn, Pb salts hav been studied. Range of concentrations: 10^{-4} g/l t $8{\cdot}10^{-4}$ g/l. The new technique gives accura quantitative results, the errors being within the usu order of magnitude admitted for spectral work. Th exposure of a metal salt to the arc must be relative brief as the carbon may become poisoned by the sal All exposures of one series should be equally lon The analytical lines of the element under investigatio should so be selected that their excitation potenti is as close as possible to that of the carbon referenc line. W. SUMME

545.82 : 535.343–

1471. Centrimetric waves and molecular structur R. FREYMANN. *Onde Élect.*, **30**, 416–24 (*Oct.*, 195 *In French.*

The absorption phenomena in solids and liquid can be accounted for by Debye's theory of dipol orientation. For gases at low pressures the absor tion is explained as due to molecular rotation, mol cular inversion and magnetic dipole effects. Th absorption bands have a fine structure which can b accounted for by the quadripolar moment and spi of the atomic nuclei. Where two isotopes of a element are present each will have its own absorptio band. Thus the study of the absorption bands give information about the isotopic content of a gas. A the frequency of the absorption bands can be measure with great precision, they provide the chemist with new analytic tool. W. T. BLACKBAN

545.8

1472. Elimination of the errors due to variations the continuous background in quantitative spectr graphy. E. ROUX AND C. HUSSON. *C.R. Acad. Sc Paris*, **231**, 770–2 (*Oct.* 16, 1950) *In French.*

The method described is for use in analysis by a spectra. S. T. HENDERSO

CRYSTALLOGRAPHY 548

548.0

1473. Change in density of KCl-crystals with the addition of bivalent ions. H. PICK AND H. WEBER. *Z. Phys.*, **128** (*No.* 3) 409–13 (1950) *In German.*

The addition of $CaCl_2$ causes a decrease in density, and the addition of $SrCl_2$ an increase. This is probably due to the fact that a bivalent ion dislodges two $K\pm$ ions, and causes an open space in the crystal. C. TURNER

548.0 : 535.3

1474. The structure and optical behaviour of th Ceylon moonstones. C. V. RAMAN, A. JAYARAMA AND T. K. SRINIVASAN. *Proc. Indian Acad. Sci. A* **32**, 123–39 (*Sept.*, 1950).

The studies made show that the schiller is a diffusio of light within the material which is macroscopicall a mono-crystal but exhibits pronounced local varia tions in its composition and refractive index. Th

soda component tends to segregate and form tiny crystallites which tend to appear with their greatest extension nearly parallel to the 100 planes of the crystal, the direction of the *c*-axis being preferred to that of the *b*-axis. The distribution of intensity of the diffused light accordingly does not exhibit a radial symmetry with respect to the direction of its maximum intensity. The intensity of the schiller and its state of polarization are also markedly influenced by the orientation of the electric vector within the crystal. The diffusion is accompanied by a marked extinction. An explanation is given of the differences in the optical effects displayed by moonstone and by labradorite in spite of their similar physical origin. A.

548.0 : 535.371

The luminescence of diamond and its relation to crystal structure. *See Abstr.* 969

548.0 : 535.6

1475. The colour of rubies. E. THILO, J. JANDER, H. SEEMANN AND R. SAUER. *Naturwissenschaften*, **37** (*No.* 17) 399 (1950) *In German.*

Rubies are Al_2O_3 with small quantities of Cr_2O_3 and a structure like corundum, which means that every Al-ion is surrounded by 6 O^{2-} and 13 Al^{3+}-ions.

As long as the amount of Cr is under 8% the colour will be red (pure Cr-ion colour) because each Cr-ion is surrounded by ions with an inert gas structure. This is experimentally verified on mixed crystals of α-Al_2O_3 and Cr_2O_3 where 8% Cr is found to be a transition point for:—the lattice constants *a* and *c* of the unit cell; the density; the magnetic susceptibility; the temperature of the change in colour from red to green (as observed in rubies) or green to red. All Cr over 8% evaporates if the crystals are heated in a H atmosphere at 1 300°. C. TURNER

548.0 : 536.413

1476. Thermal expansion of crystals. II. Magnetite and fluorite. S. S. SHARMA. *Proc. Indian Acad. Sci. A*, **31**, 261–74 (*April*, 1950).

With the help of interferometric method, thermal expansion of magnetite (up to 710°C) and fluorite (up to 650°C) has been studied. In the case of the former the coefficient of expansion has been found to vary from $8{\cdot}70\times10^{-6}$ at 41·3°C to $24{\cdot}20\times10^{-6}$ at about 570°C (the Curie-point), after which there is a sudden fall in its value. It is found that thereafter the magnetic transformations have no perceptible effect on the thermal expansion. For fluorite the coefficient of expansion has been found to vary from $9{\cdot}36\times10^{-6}$ at 43°C to $36{\cdot}70\times10^{-6}$ at 637·3°C. Grüneisen's constant has been calculated for both these crystals and is found to vary considerably with temperature. A.

548.0 : 537.226.2

Domain structure of Rochelle salt. *See Abstr.* 1041

548.0 : 537.311.33 : 539.374

1477. Influence of plastic flow on the electrical and photographic properties of the alkali halide crystals. F. SEITZ. *Phys. Rev.*, **80**, 239–43 (*Oct.* 15, 1950).

The influence of plastic flow on the ionic conductivity and darkenability of the alkali halides is discussed on the basis of the assumption that vacant lattice sites are generated during lattice flow and condense to form clusters during a subsequent period of time. These assumptions appear to lead to a reasonable interpretation of the available experiments on the changes in properties of the alkali halides which accompany plastic flow. The bleaching action of plastic flow on coloured crystals is also discussed, although the mechanism appears to be much less apparent in this case. A.

548.0 : 538.69 : 538.214

The de Haas-van Alphen effect. *See Abstr.* 1176

548.0 : 539.32 : 534.321.9

1478. Elastic constants of some cubic nitrates. J. BHIMASENACHAR AND T. SESHAGIRI RAO. *Proc. Nat. Inst. Sci., India*, **16**, 235–40 (*July–Aug.*, 1950).

The elastic constants of single crystals of $Ba(NO_3)_2$, $Sr(NO_3)_2$ and $Pb(NO_3)_2$ have been determined employing the wedge method. They are $C_{11} = 5{\cdot}93$, $C_{12} = 1{\cdot}89$, $C_{44} = 1{\cdot}21$ for $Ba(NO_3)_2$; $C_{11} = 4{\cdot}73$, $C_{12} = 2{\cdot}18$, $C_{44} = 1{\cdot}46$ for $Sr(NO_3)_2$ and $C_{11} = 4{\cdot}56$, $C_{12} = 3{\cdot}09$, $C_{44} = 1{\cdot}37$ for $Pb(NO_3)_2$. A.

548.0 : 539.32 : 534.321.9

1479. Elastic constants of corundum. J. BHIMASENACHAR. *Proc. Nat. Inst. Sci., India*, **16**, 241–3 (*July–Aug.*, 1950).

The values for a single crystal of natural corundum, determined by the wedge method, are $C_{11} = 46{\cdot}5$, $C_{33} = 56{\cdot}3$, $C_{44} = 23{\cdot}3$, $C_{12} = 12{\cdot}4$, $C_{13} = 11{\cdot}7$ and $C_{14} = 10{\cdot}1$ in units of 10^{11} dynes/cm^2. A.

548.0 : 539.373

1480. The generation of vacancies by dislocations. F. SEITZ. Letter in *Phys. Rev.*, **79**, 1002–3 (*Sept.* 15, 1950).

The large density of lattice vacancies required by some experiments can be produced by the growth of interstitial planes (c.5 atomic dimensions). These can be generated in large numbers by a Burgers spiral—it is shown that the mechanism has a "prismatic character" [Abstr. 737 (1951)]. J. R. MADDOX

548.0 : 539.373

1481. Spiral prismatic dislocations and the origin of slip-bands. F. SEITZ. Letter in *Phys. Rev.*, **79**, 1003–4 (*Sept.* 15, 1950).

It is shown that the condensation of lattice vacancies along dislocations of the spiral prismatic type (see preceding Abstr.) can account for the mosaic structure of crystals and the observed regularity of slip bands. J. R. MADDOX

548.0 : 539.67

Variation of amplitude-dependent internal friction in single crystals of copper with frequency and temperature. *See Abstr.* 1385

548.0 : 541.135.4

1482. The ionic conductivity of Li-halide crystals. Y. HAVEN. *Rec. Trav. Chim. Pays-Bas*, **69**, 471–89 (*Nov.*, 1950).

The ionic conductivity of mixed crystals of Li halides and Mg halides has been measured. From these measurements the mobility of Li vacancies and the concentration of vacancies in pure Li halides has been derived, with the two assumptions that the defects in Li halides are Schottky defects and the mobility of halide vacancies is negligibly small. The conductivity can be represented by an equation of the form:

$$\kappa = A\exp(-U/kT)[1+\{1+(4A'/a^2)\exp(-E/kT)\}^{\frac{1}{2}}]$$

in which κ is the specific conductivity, U the height of the potential barrier which must be surmounted by the Li^+ ions when moving through the crystal, E the energy required for the formation of a pair of vacancies, a the concentration of Mg halide and A' and A constants. The magnitude of E, U, A and A' have been compared with theoretical estimates. A.

548.1 : 548.7

1483. The complete and unambiguous designation of space groups by tables of characters. II. P. NIGGLI. *Acta Cryst.*, 3 (*No.* 6) 429–33 (1950) *In German.*

The method of representing space groups by tables of characters given in Part I [Abstr. 7387 (1949)] is now extended to space groups with face- or body-centred translation groups and to those of the tetragonal, hexagonal and cubic systems. A.

548.24

1484. Mechanical twinning in white tin. R. CLARK, G. B. CRAIG AND B. CHALMERS. *Acta Cryst.*, 3, 479 (*Nov.*, 1950).

548.33

1485. Polymorphism of the chlorites. I. Ordered structures. G. W. BRINDLEY, B. M. OUGHTON AND K. ROBINSON. *Acta Cryst.*, **3**, 408–16 (*Nov.*, 1950).

A variety of polymorphic forms has been found among single crystals of chlorites, consisting of ordered, partially ordered and disordered structures. Four different ordered structures have been analysed in detail. The reflections are of 2 types: those with $k = 3n$ are similar for all chlorites and confirm Pauling's structure of the chlorite layer and the *ac* projection of McMurchy's structure. Reflections with $k \neq 3n$ show marked variations for the different ordered structures and degenerate into two-dimensional streaks for completely disordered structures. Four ordered structures are analysed in terms of 3 types of layer with displacements along the *a* and *b* axes, but a simpler description is given in terms of layers of a single type which are displaced along 1 of the 3 "hexagonal" *a* axes by $-\frac{1}{3}a$, together, in some structures, with regularly occurring rotations of $\pm 120°$ about the normal to the basal cleavage plane, which is the plane of the layers. A.

548.4 : 539.374

1486. The influence of deformation by Piobert lines on the charging of Fe with cathodic H. J. DUFLOT AND G. CHAUDRON. *C.R. Acad. Sci., Paris*, **231**, 620–1 (*Sept.* 25, 1950) *In French.*

Test pieces partially traversed by Piobert (or Lüders) lines show growths or blisters (cloques), concentrated in the regions not showing the lines, and arising from the formation of H_2 in the lattice imperfections. The regions were separated by cutting and the ratio of the amounts of gas released in the deformed/undeformed regions found to be 0·57. It is deduced that the Piobert mechanism modifies the structure in such a way as to reduce the larger imperfections in the lattice. A. J. KENNEDY

548.5

1487. An electron-diffraction study of chalcopyrite film grown upon enargite. T. ITO AND H. SAWADA. *Acta Cryst.*, 3 (*No.* 6) 434–5 (1950).

A natural chalcopyrite film coated on (001) of enargite has been studied using electron diffraction. Chalcopyrite is so orientated that its (112), (1$\bar{1}$0) ar (11$\bar{4}$) are respectively parallel or nearly parallel (001), (010) and (100) of enargite.

548

1488. Calcium carbonate and its hydrates. BROOKS, L. M. CLARK AND E. F. THURSTON. *Phil Trans A*, **243** (*No.* 861) 145–67 (1950).

Metastable phases of $CaCO_3$ tend to be precipitat from aqueous solution in the presence of certa added substances. Calcite (stable), aragonit vaterite and the hexa and monohydrates of CaC have been prepared in the presence of Calgon magnesium ion, depending on conditions of pr cipitation. The crystals obtained contain appreciab quantities of P or Mg, also distortion of X-ray pattern is common. The absorption of additive therefo appears to be important in influencing nucleatio and the formation of metastable states. J. A. FRANK

548.5 : 539.23

A note on the orientated overgrowths of metal film on single crystal inorganic substrates. *See Abstr.* 135

548.5

1489. Prismatic cleavage of molybdenite. R. BAILEY *Acta Cryst.*, 3 (*No.* 6) 477 (1950).

548.572 : 541.183.0

Influence of crystal structure on the adsorption o foreign molecules. *See Abstr.* 1450

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7 : 539.1

Lattice perturbation due to thermal vibrations *See Abstr.* 1212

548.734.842.

1490. Relations among the crystal structure factors H. HAUPTMAN AND J. KARLE. *Phys. Rev.*, **80**, 244– (*Oct.* 15, 1950).

New relations among the structure factors and thei magnitudes have been derived which take the form of inequalities. In the limiting case of point atoms some of these reduce to equalities and many additiona relations are also valid. The crystal structure problem for point atoms is discussed from the point of view of equivalent sets of algebraic equations. In thi development no special symmetry relations are required. Because of the complexity of the result of this paper, their general application remains a problem to be solved. A.

548.73

1491. The X-ray scattering from a hindered rotator T. H. WALNUT, JR., AND G. B. CARPENTER. *Acta Cryst.*, 3, 474–5 (*Nov.*, 1950).

548.73

1492. A new type of X-ray scattering. K. DAS GUPTA. Letter in *Nature, Lond.*, **166**, 563–4 (*Sept.* 30 1950).

Theory of incoherent scattering in an insulator (e.g. diamond) in which X-ray photons may give up enough energy to raise electrons above the first forbidden zone. A. R. STOKES

548.735

1493. A geometric approach to the crystal structure problem. H. HAUPTMAN AND J. KARLE. Note in *Acta Cryst.*, **3**, 478 (*Nov.*, 1950).

The theory of a suggested method of finding atomic co-ordinates from X-ray diffraction data, using vector representation of the complex numbers involved in the intensity formula. A. R. STOKES

548.735.2

1494. The probability distribution of X-ray intensities. IV. New methods of determining crystal classes and space groups. D. RODGERS. *Acta Cryst.*, **3**, 455–64 (*Nov.*, 1950).

The application of the two methods of intensity statistics, the "distribution method" and the "method of averages," to the identification of the symmetry elements in a crystal is discussed. It is shown that each symmetry element has a distinct and recognizable effect on the weighted reciprocal lattice, and it is concluded that, from X-ray intensities alone, each crystal class may theoretically be identified uniquely. As a result 215 of the 219 space groups are also by these methods uniquely identifiable from X-ray data. Information concerning symmetry elements may also be obtained which is of value in structural investigations. A brief consideration is given to the remaining two pairs of space groups $I222$, $I2_12_12_1$ and $I23$, $I2_13$. A.

548.735.2

1495. Tables of the characteristics of the vector representations of the 230 space groups. M. J. BUERGER. *Acta Cryst.*, **3**, 465–71 (*Nov.*, 1950).

All space groups can be distinguished in their vector representations, except that one cannot distinguish between the members of the 11 enantiomorphous pairs. This means that the space groups of all crystals can be distinguished in their Patterson syntheses, except that one cannot distinguish between the members of the 11 enantiomorphous pairs. All but 8 of the distinguishable space groups can be recognized in Patterson synthesis merely by their symmetry plus the locations of heavy concentrations. Of these 8, 5 can be distinguished by simple qualitative features of the patterns in the concentration loci, while the other 3 can be distinguished if the data for the Patterson synthesis is on an absolute basis. A table listing the symmetrical concentrations for the 230 space groups is given. These concentrations are also the only possible Harker sections. A.

548.735.4 : 518.5

1496. A machine for synthesizing two-dimensional Fourier series in the determination of crystal structures. H. SHIMIZU, P. J. ELSEY AND D. MCLACHLAN, JR. *Rev. Sci. Instrum.*, **21**, 779–83 (*Sept.*, 1950).

An electromechanical analogue machine is described which performs a two-dimensional Fourier synthesis for use primarily in X-ray crystal structure calculations, $\rho(xy) = \sum_h \sum_k F_{hko} \cos 2\pi(hx + ky)$. The analogue to a term in this summation is obtained through the use of a pair of selsyns as a synchro-variable transformer somewhat similar to its use in servomechanisms. $\rho(xy)_{hk}$ is represented by the output voltage, F_{hko} by the input voltage, and $2\pi hx$ and $2\pi ky$ are the angles of rotation of the primary and secondary rotors respectively. A system of crossed shaft and cascading gear trains turns the rotors to the appropriate angles for each selection of point (x, y) in the unit cell. The present machine handles h and k values up through 8, but provision is made for future extension through 16. Computations are shown for two known structures to indicate the results obtainable with the machine. A.

548.735.46

1497. Vector maps of hydrated protein crystals. D. WRINCH. *Acta Cryst.*, **3**, 475–6 (*Nov.*, 1950).

548.736.1

1498. On the symmetry of graphite. J. S. LUKESH. *Phys. Rev.*, **80**, 226–9 (*Oct.* 15, 1950).

X-ray diffraction evidence indicates that the symmetry of graphite can be no higher than twofold. Evidence consists of twin observations and the occurrence of satellite reflections, both of which are incompatible with sixfold symmetry. Both phenomena strongly suggest that the classical concept of equivalent carbon-carbon bonds must be discarded in favour of one involving unequal bond lengths and bond angles. A.

548.736.3

1499. Studies on oxides and fluorides of lead. A. BYSTRÖM. *Inaug. Diss. Univ. Stockholm* (1950) 12 *pp.*

Summary and review of the author's work on these compounds. See Abstr. 3126 (1945); 895, 901 (1946); 2703 (1947); 1456, 1458, 1507 (1951).

A. J. C. WILSON

548.736.3

1500. The crystal structure of decaborane, $B_{10}H_{14}$. J. S. KASPER, C. M. LUCHT AND D. HARKER. *Acta Cryst.*, **3**, 436–55 (*Nov.*, 1950).

Crystals prepared by sublimation at room temperature, or above, show a high degree of polysynthetic twinning, giving rise to diffuseness of reflections for which h and k are odd. In the untwinned condition, the crystal is monoclinic, but pseudo-orthorhombic, and it is convenient to choose the twofold axis in the **c** direction. The space group is then $C112/a$–C_{2h}^4. With $a_0 = 14{\cdot}45$, $b_0 = 20{\cdot}88$, $c_0 = 5{\cdot}68$ Å, $\beta = 90{\cdot}0°$, the cell contains 8 molecules of $B_{10}H_{14}$ and the calculated density is $0{\cdot}96$ g.cm^{-3}. The individual crystals that make up the actual, highly twinned crystalline edifice are so short in the **b** direction (a few unit translations) that it is convenient to consider the system as a partially ordered crystal, the disordered state of which is described by a unit cell one-quarter the size of the one mentioned above. The dimensions of this small cell are $a_0' = 7{\cdot}225$, $b' = 10{\cdot}44$, $c_0' = 5{\cdot}68$ Å, and it contains $2B_{10}H_{14}$ or $(\frac{1}{2}B)_{20}(\frac{1}{2}H)_{28}$. The disordered structure based on this cell explains all the sharp spots observed—its space group is $Pnnm$–D_{2h}^{12}. The solution of the structure resulted from a successful application of phase inequalities in obtaining an approximate projected structure [on (001)]. The molecule is required by the space group to have only a twofold axis but appears to have two mirror planes as well; it has the symmetry $mm2$. The B atoms are at 10 of the vertices of a somewhat distorted regular icosahedron, two neighbouring vertices of which are

unoccupied. The resulting arrangement forms 2 regular pentagonal pyramids with a common base edge. The angle between the base planes of those pyramids is 76°. Each of 10 H atoms is attached to a single B atom in the direction of a fivefold axis of the icosahedron. The remaining 4 H each bridge 2 B atoms. This structure is interpreted in terms of resonating single bonds, such as used by Pauling in describing metallic binding. A.

548.736.3

1501. Preparation of single crystals of manganous fluoride. The crystal structure from X-ray diffraction. The melting point and density. M. GRIFFEL AND J. W. STOUT. *J. Amer. Chem. Soc.*, **72**, 4351–3 (*Oct.*, 1950).

The preparation of single crystals of MnF_2 from the melt in an atmosphere of HF is described. From X-ray diffraction measurements the parameters of the tetragonal unit cell, each containing two molecules of MnF_2, are $a = (4{\cdot}8734 \pm 0{\cdot}0005) \times 10^{-8}$ cm and $c = (3{\cdot}3103 \pm 0{\cdot}0010) \times 10^{-8}$ cm at 25°. The parameter u that determines the position of the fluorine atoms in the space group D_{4h}^{14} is $0{\cdot}310 \pm 0{\cdot}005$. The density calculated from the X-ray parameters is $3{\cdot}925 \pm 0{\cdot}003$ g cm^{-3}. The measured density is $3{\cdot}922 \pm 0{\cdot}004$ at 25°. The melting point of MnF_2 is $929{\cdot}5 \pm 0{\cdot}5$°. A.

548.736.3

1502. Precision determination of the lattice constants of zinc oxide. R. B. HELLER, J. MCGANNON AND A. H. WEBER. *J. Appl. Phys.*, **21**, 1283–4 (*Dec.*, 1950).

A total of 350 back-reflection ZnO powder X-ray diffraction lines on 25 photographic films have been measured and analysed by the Cohen analytical least squares extrapolation method to yield $a = (3{\cdot}2495 \pm 0{\cdot}0000_2)$ Å, $c = (5{\cdot}2069 \pm 0{\cdot}0001_1)$ Å, where the stated errors are the probable errors. The statistical reliability of the results is emphasized. In the measurement of the Debye–Scherrer ring radii the accuracy obtained with a metric scale and indicator (employing no optical lens system) and with a dividing engine equipped with a microscope are compared and the former simpler method is found more reliable. It is concluded that the use of precision measuring instruments for observing diffraction ring radii are unnecessary and even undesirable apparently because the magnifying power of the optical system of precision micrometers leads to uncertainties in settings on photographic lines. A.

548.736.4

1503. The unit cell and space group of ammonium metavanadate, NH_4VO_3. J. S. LUKESH. *Acta Cryst.*, **3**, 476–7 (*Nov.*, 1950).

548.736.4

1504. Crystal structure of triphyline. D. DESTENAY. *Mem. Soc. Roy. Sci., Liège*, **10** (*No.* 3) 5–28 (1950) *In French.*

$LiFePO_4$ is orthorhombic, *Pbnm*, $a = 4{\cdot}74 \pm 5$, $b = 10{\cdot}42 \pm 5$, $c = 6{\cdot}07 \pm 5$ kX, $Z = 4$, measured density 3·45. The Li atoms are at centres of symmetry, the Fe on mirror planes, contrary to the conclusions of Gossner and Strunz [*Z. f. Kristallogr.*, **83**, 415 (1932)]. A full redetermination of the structure by Patterson and Fourier projection gives $R = 28\%$. A. J. C. WILSON

548.736

1505. Cerium oxyfluoride and its lattice structure. W. FINKELNBURG AND A. STEIN. Letter in *J. Chem. Phys.*, **18**, 1296 (*Sept.*, 1950).

548.736

1506. Atomic positions and vibrations in the ferroelectric $BaTiO_3$ lattice. W. KAENZIG. Letter in *Phys. Rev.*, **80**, 94–5 (*Oct.* 1, 1950).

548.736

1507. The structure of quenselite $PbMnO_2OH$. A. BYSTRÖM. *Ark. Kemi Min. Geol.*, **19A**, *Paper* 3, 9 *pp.* (1944).—See also Abstr. 1499 (1951).

548.736

1508. The crystal structure of hexammine-cobaltic hexachlorothalliate, $Co(NH_3)_6TlCl_6$, and hexammine-cobaltic hexabromothalliate, $Co(NH_3)_6TlBr_6$. WATANABÉ, M. ATOJI AND C. OKAZAKI. *Acta Cryst.*, **3**, 405–8 (*Nov.*, 1950).

548.736

1509. The crystallography of monoclinic, basic copper nitrates. $Cu(NO_3)_2 . 3Cu(OH)_2$. I. V. NOWACKI AND R. SCHEIDEGGER. *Acta Cryst.*, 472–3 (*Nov.*, 1950) *In German.*

548.736

1510. Structures of boroferrites. E. F. BERTAUT. *Acta Cryst.*, **3**, 473–4 (*Nov.*, 1950) *In French.*

548.736

1511. Rapid and precise method for obtaining the ratio c/a for an apatite. H. BRASSEUR. *Bull. Acad. Roy. Belge Cl. Sci.*, **36** (*No.* 6) 521–4 (1950) *In French.*

The ratio provides a means of distinguishing between similar but not identical apatites. Curves are drawn giving c/a as a function of the ratio of the angular separations of two pairs of neighbouring reflections on powder photographs, e.g. the ratio $(\theta_{231} - \theta_{123})/(\theta_{004} - \theta_{402})$, where θ_{hkl} is the Bragg angle of the hkl reflection. Values of c/a accurate within about 0·1% can be read off when the ratio of the angular separations is measured within 10%. Results are given for 11 substances. A. J. C. WILSON

548.736

1512. Mixed oxides with layer lattices. II. Structure of $BaBi_4Ti_4O_{15}$. B. AURIVILLIUS. *Ark. Kemi*, **2**, *Paper* 37, 519–27 (1950).

See Abstr. 4488–9 (1950) for parts I and II.

548.736

1513. The development and the surface energy of the planes of the primary rhombohedron in α-quartz. B. D. SAKSENA AND L. M. PANT. Letter in *J. Chem. Phys.*, **18**, 1304–5 (*Sept.*, 1950).

See Abstr. 7440 (1949). The surface energy of various faces bounding quartz crystals is calculated from the number of Si–O bonds cut by each, and is found to be lowest (~ 1 340 ergs/cm^2) for the rhombohedron r faces. A. J. C. WILSON

548.73

1514. The crystal structure of potassium sodium *dl*-tartrate tetrahydrate, $KNaC_4H_4O_6 . 4H_2O$. F. SADANAGA. *Acta Cryst.*, **3** (*No.* 6) 416–23 (1950).

548.737

1515. The crystal structure of hexamethylenediamine. W. P. BINNIE AND J. M. ROBERTSON. *Acta Cryst.*, **3**, (*No.* 6) 424–9 (1950).

548.737

1516. Crystal structure of phenanthrene. B. S. BASAK. *Indian J. Phys.*, **24**, 309–14 (*July*, 1950).

See Abstr. 4048 (1948). Preliminary determination. Monoclinic, $P2_1$, $a = 8{\cdot}57$, $b = 6{\cdot}11$, $c = 9{\cdot}47$ Å, $\beta = 82° 30'$, $Z = 2$, x and z parameters from the centrosymmetric projection, y by trial and error.

A. J. C. WILSON

548.737

1517. Crystal structure of *syn p*-chlorobenzaldoxime. B. JERSLEV. Letter in *Nature, Lond.*, **166**, 741–2 (*Oct.* 28, 1950).

548.74

1518. The application of electron diffraction to the study of alloy single crystals. H. RAETHER. *C.R. Acad. Sci., Paris*, **231**, 653–5 (*Oct.* 2, 1950) *In French.*

Single crystals of alloys, thin enough to be examined in transmission by electron diffraction, are prepared by condensation in a vacuum on the face of a crystal of NaCl heated to a few hundred degrees. The order-disorder process in $AuCu_3$ is followed by watching the appearance and disappearance of the relevant spots in the electron diffraction photograph.

J. THEWLIS

548.74

1519. An exception to Friedel's law in electron diffraction. II. Theoretical consideration. K. KOHRA, R. UYEDA AND S. MIYAKE. *Acta Cryst.*, **3**, 479–81 (*Nov.*, 1950).

The observation that Friedel's law ceases to hold for electron diffraction when the incident beam lies in the (110) face of zincblende, reported by Miyake and Uyeda [Abstr. 7618 (1950)], is interpreted on Bethe's dynamical theory of diffraction. J. THEWLIS

GEOPHYSICS 55

550.312

1520. On the influence of the law of distribution of density in the earth's interior on the luni-solar variation of gravity at a point. P. J. MELCHIOR. *Geofis. Pura Appl.*, **16**, 105–12 (*April–June*, 1950) *In French.*

Using Bullen's data for the variation of density in the earth's interior, the author deduces the equation $\delta = 1 + 0{\cdot}244\,h$, h being the first Love's number and δ the ratio of the observed amplitudes of the luni-solar variation of gravity to those calculated assuming a perfectly rigid earth. The value of h thus obtained cannot however be used to determine directly the earth's modulus of rigidity because we must take into account the variations of period and amplitude of the chandlerian motion of the pole. A simple relation is deduced between δ and γ (deviation of the vertical). E. M. FOURNIER D'ALBE

550.312

1521. On the isostatic structure of the earth's crust. W. HEISKANEN. *Ann. Acad. Sci. Fennicae, Ser. A III* (*No.* 22) 60 *pp.* (1950).

A comprehensive survey of progress made during the last decade in the methods of reduction of gravity values and in the isostatic study of certain regions of the earth's crust. Full bibliography.

E. M. FOURNIER D'ALBE

550.341

1522. The photoelectric seismograph. J. A. VOLK. *Bull. Seism. Soc. Amer.*, **40**, 169–73 (*July*, 1950).

A seismograph has been developed at the Institute of Technology of St. Louis University, in which the usual photographic method is replaced by a combination of a 918-photoelectric cell, an amplifier and a pen-recorder. A seismometer of the Sprengnether type has been used. D.C.-amplification is avoided by applying the voltage to the photocell in the form of pulses (whose shape can be varied). The pulses of output current so obtained can readily be amplified in a convential RC-amplifier, the rectified output from which being sufficient to drive a pen-and-ink recorder. Either a linear or an exponential response can be obtained from the instrument. Remote control may be employed over a distance of several miles. A. BEER

550.341

1523. Dependence of seismic wave velocity upon depth and lithology. S. S. WEST. *Geophysics*, **15**, 653–62 (*Oct.*, 1950).

Interval velocity v in relatively pure clastic sediments can be expressed as a function of depth z by the formula $v = v_0(1 + cz/v_0^4)$, where v_0 is a constant characteristic of the rock and $c = 3{\cdot}3$ km^3/sec^4, approximately. From this relation can be deduced a function $v^4 = 9{\cdot}5\,cz$, which prescribes the minimum velocity possible at a given depth and the maximum depth at which a given velocity can occur. An upper limit of velocity is set by data from limestones and from refraction measurements at depths from 8 to 50 km. The limiting curves converge near 150 km depth toward a function $v^5 = 180z$, which holds from 200 km to the boundary of the core at 2 900 km. The relation of near-surface velocity to porosity is discussed, and it is shown how one can deduce the motion of shorelines during deposition. A.

550.341 : 621.395.645 : 620.178.4

1524. The application of feedback to an electro-mechanical transducer for seismograph testing. P. M. HONNELL. *Bull. Seism. Soc. Amer.*, **40**, 217–31 (*July*, 1950).

Advantages of feedback application are the complete masking of the resonance peak in the transducer velocity response, and immunity of the platform motion to variations in mechanical loading by the seismographs undergoing test. The superiority of the feedback technique is shown by direct comparison with the operation of the transducer electrically damped by a short-circuited ring. The transducer constant-velocity output is easily converted to constant amplitude or constant acceleration by means of simple coupling networks. A.

550.381

1525. Quantitative interpretation of vertical magnetic anomalies over veins. K. L. Cook. *Geophysics*, **15**, 667–86 (*Oct.*, 1950).

By using ordinary magnetic induction methods of analysis, Haalck, Heiland and others have developed formulas which express the magnetic anomaly over a vertical or inclined vein of tabular shape as a function of the susceptibility, dimensions, shape and disposition of the vein, and of the strength and direction of the earth's magnetic field. On the basis of these fundamental formulas, other formulas for the vertical component of the magnetic field are derived in the present paper for such veins in intermediate northern magnetic latitudes. Special emphasis is given to the orientation of the veins relative to the magnetic north direction. The importance of the transverse horizontal magnetization effect under certain conditions of orientation is demonstrated. It is shown mathematically that small vertical magnetic anomalies are to be expected for thin veins striking east and dipping south at an angle equal to, or approximately equal to, the complement of the angle of magnetic inclination. A.

550.381 : 538.23

1526. Magnetic hysteresis of igneous rocks. J. McG. Bruckshaw and B. S. Rao. *Proc. Phys. Soc., Lond. B*, **63**, 931–8 (*Nov.*, 1950).

A rapid method has been developed for the investigation of the magnetic properties of igneous rocks. The specimens examined show the normal properties to be expected from a mixture of magnetically different constituents. In particular, high coercivities have been found. The significance of the results in relation to natural permanent magnetism in rocks is discussed. A.

550.384

1527. On the effect of a current of ionized air upon the earth's magnetic field. C. Truesdell. *J. Geophys. Res.*, **55**, 247–60 (*Sept.*, 1950).

An equation governing the perturbation field induced by the motion of a conducting fluid in a uniform magnetic field is derived. A general solution for the steady case is presented and discussed, with a view to explaining the local irregularities in the earth's magnetic field. A.

550.384

1528. "Sudden commencements" in geomagnetism. W. Jackson. Letter in *Nature, Lond.*, **166**, 691–2 (*Oct.* 21, 1950).

The suggestion made by Ferraro and Parkinson [Abstr. 4510 (1950)] that "sudden commencements" (SC) which have a preliminary movement in the horizontal force opposite to that of the main impulse (Type II SC) may depend on geomagnetic longitude, does not seem to be borne out by the records of Sitka for the years 1946–48. The author, however, points out that because the period examined is too short no great weight can be attached to this. Sitka may also be an anomalous station. He suggests further that the preliminary movement in Type II SCs may be connected with the fact that some low latitude stations show a reduced amplitude in the oscillations of the traces. This suggests a possible dependence on latitude, but Apia and Hermanus scarcely support this. Damping caused by induce ionospheric currents is also suggested as a possib cause of the absence of a preliminary movement SCs. V. C. A. FERRAR

550.83

1529. The case for gravity data from borehole N. J. Smith. *Geophysics*, **15**, 605–36 (*Oct.*, 1950).

The immediate urge for gravity meter surveys i boreholes is the desire to improve the gravity metho itself but there are other potential uses for data s obtained. Borehole gravity surveys, through th influence of density, would be related to numerou important rock properties such as the velocity o seismic waves, the coefficient of reflection, the elec trical resistivity, lithology, porosity, and the kind and states of fluids in the rock. Therefore, in additio to improvement in gravity prospecting, the dat would bear upon seismic techniques and, dependin on accuracy and detail, upon the interpretation o lithologic and electric logs. The more obvious o the possible uses are indicated and some of th problems and inherent limitations holding up develop ment are discussed. A

550.837.

1530. An induction pulse method for the detectio of petroleum. M. Müller. *Geofis. Pura Appl.*, 17 54–60 (*July–Sept.*, 1950) *In German.*

An induction pulse method is described, base upon the measurement of a dielectric dispersio phenomenon. This method opens the possibility of direct and selective detection of the petroleum at depth of more than 6 000 ft. The selective reactio is based upon the variation of the exciting conditions A

550.837.

1531. The electromagnetic field due to induce currents in a conductive slab of finite dimensions A. Belluigi. *Geophysics*, **15**, 687–703 (*Oct.*, 1950).

The theory is developed of the electromagneti eddy fields relative to a plane, thin, conducting sla with its plane perpendicular to the horizontal ground The mineral slab is subjected to an alternating inducing magnetic field, paralleling the surface o the ground. After discussing the problem of the finite slab, the special case is considered of a semi infinite slab (Peters and Bardeen, 1930), e.g., the mineralized vein type, using existing formulas. With adequate development they can be used in the con struction of theoretical graphs of the electromagnetic effects of the slab in which eddy currents are produced The limiting dimensions, both of the dyke (first case of the finite slab), and the vein (second of the semi infinite slab case), act noticeably upon the measurable electromagnetic effect, and the influence diagrams characterize the slab-shaped, conducting mineral. Therefore some fundamental characteristics on the surface and at depth of the slab and its extension in depth (thickness) can be deduced. A

550.93

1532. Argon^{40} and the age of the earth. H. E. Tatel. *J. Geophys. Res.*, **55**, 329–36 (*Sept.*, 1950).

The A^{40} in the atmosphere is considered to be of terrestrial origin, generated in the decay of K^{40}. Recent measurements by Aldrich and Nier, and by

Wiedenbeck and Sawyer of the decay of K into A indicate the crustal K can account for less than one-tenth of the atmospheric A. The meteoric measurements make it possible to estimate the K abundance within the earth's mantle, and there is enough to have produced all the A in the atmosphere in about $1{\cdot}5\times10^9$ years. However, if the A has not escaped from the earth's interior since the formation of the crust, then the earth must have existed at least 5×10^8 years prior to crustal formation. These estimates are limited by the uncertainty in the estimates of the amount of A entrapped within the earth. A.

ATMOSPHERE . METEOROLOGY 551.5

551.508.5 : 621.317.39

1533. An electrical method of resolving true wind velocity aboard ship. H. D. HAWKES AND J. M. LAWS. *Instn Elect. Engrs, Paper* 1079 (1950) 4 *pp.* [*Early Proof Issue*].

A knowledge of the behaviour of the true wind aboard ship is essential in modern meteorological practices. The true wind velocity can be resolved from the measured speed and direction of the relative wind and of the ship. A method of polar resolution by alternating-current representation of force vectors is shown, together with an outline of the apparatus needed for primary measurement and resolution. The accuracy of the original resolving gear under practical conditions is indicated. A.

551.510.41 : 541.144.8

1534. The photochemistry of atmospheric water vapor. D. R. BATES AND M. NICOLET. *J. Geophys. Res.*, **55**, 301–27 (*Sept.*, 1950).

Solar radiation dissociates water vapour into H atoms and OH radicals. H_2 and H_2O_2 molecules, and perhydroxyl radicals, are also produced as a result of subsequent chemical reactions with the allotropic forms of O. The rate of the oxidizing processes falls off more rapidly with increase of altitude than does that of the reducing processes, and the H compounds are almost completely broken down at about the 90-km level (or even lower). There is a continual escape of the H atoms into interplanetary space; but the liberated O atoms remain in the atmosphere, and the number that must thus have been added in geological time seems to be comparable with the number now present. Consideration of the general equilibrium reveals several features of interest, such as, for example, the existence of a thin layer of molecular H. In spite of the prominence of the Meinel bands, the concentration of OH radicals is quite small. It is thought that these radicals are excited during, rather than after, their formation. The mechanism proposed is two-body collisions between H atoms and O_3 molecules. A.

551.510.5

1535. Upper atmospheric nomenclature. S. CHAPMAN. *Bull. Amer. Met. Soc.*, **31**, 288–90 (*Oct.*, 1950).

It is proposed that stratosphere shall signify solely the nearly isothermal region above the troposphere; that the layer between the stratosphere and the deep temperature minimum somewhat below 100 km be called the mesosphere; that the layer of rising temperature over this minimum be called the thermosphere. On the basis of composition, it is proposed to divide the atmosphere into the homosphere (of substantially uniform composition from the ground upwards) and the heterosphere (of different composition). On the basis of electron density, a correlative to ionosphere is proposed, the neutrosphere. Using pause to signify upper boundary, the stratopause, mesopause, homopause and neutropause are defined. Peak is suggested as the name for a level of maximum, e.g., mesopeak, ozone peak, E or F peak. Incline and decline are names suggested for the parts of a peaked layer below and above the peak, e.g., mesoincline (for the layer of rising temperature just above the stratosphere), mesodecline, E or F incline or decline. A "dip" in a peaked layer is called a syncline. A.

551.510.535

1536. World-wide *F*2 ionization. R. EYFRIG, E. HARNISCHMACHER AND K. RAWER. *J. Geophys. Res.*, **55**, 261–6 (*Sept.*, 1950).

It seems of interest to characterize in detail the diurnal variation of the *F*2 layer when "effects of longitude" are inquired into. For this purpose, we use the maxima and minima of critical frequencies, characterizing the heights by the factor "*M*3 000." Conditions seem to be more complicated than former analysis has revealed. A.

551.510.535

1537. Methods of determining the ionization variation above the maximum in the *E*-layer. K. BIBL. *Naturwissenschaften*, **37** (*No.* 16) 373–4 (1950) *In German.*

Short note on methods of deducing the form of the ionization gradient in the *E*-layer above the level of maximum density. Some examples of the application of the methods to typical (h', f) curves are given.

W. J. G. BEYNON

551.510.535 : 621.317.39 : 621.396.11

1538. An automatic ionospheric recorder for the frequency range 0·55 to 17 Mc/s. R. NAISMITH AND R. BAILEY. *Instn Elect. Engrs, Paper* 1010 (1950) 8 *pp.* [*Early Proof Issue*].

The servo-electric ionospheric recorder in use at the Radio Research Station, Slough, is described in relation to its general use for routine recording purposes. It contains 5 essential parts: (*a*) a pulse transmitter, (*b*) a pulse receiver, (*c*) a servo-electric control working through a discriminator to keep the receiver in tune with the transmitter, (*d*) a calibration unit and (*e*) a recording unit. This type of equipment has been in continuous use for over six years, producing hourly records of ionospheric conditions; the record consists of a graph of equivalent height of reflection of radio waves as a function of frequency. The height and frequency graticules are produced simultaneously with the echoes, and the date and time of the observations are recorded automatically. A.

551.513.1

1539. On the dynamics of the general atmospheric circulation. C. H. B. PRIESTLEY. *Aust. J. Sci. Res. A*, **3**, 1–18 (*March*, 1950).

The annual flow of angular momentum across latitudes 30–35° effected by north and south currents lying side by side (cylonic and anticyclonic "eddies") appears insufficient to balance the angular momentum generated at the surface in lower latitudes. The discrepancy suggests that there must be also a mean poleward drift of air at upper tropospheric and lower stratospheric levels across the latitudes of the mean surface high pressure belt, with a counterdrift which occurs at least in part in near-surface levels. Since these drifts are found in latitudes where the vertical wind shear is greatest, they constitute an important agency in the transport of angular momentum from its source region in the tropics to the sink region of higher latitudes. This significant contribution is masked in studies of interchange which invoke the assumption of geostrophic wind. The "index" representing the total strength of the tropical easterly surface winds, which fluctuates considerably, relates closely to the rate of generation of angular momentum in the tropics. On the basis of the drifts referred to above, a descriptive theory of the index cycle is developed, which links the fluctuations of index with the fluctuations in strength and in latitude of the jet stream. A.

551.521.2

1540. Radiative heat transfer in the air near the ground. E. L. DEACON. *Aust. J. Sci. Res. A*, **3**, 274–83 (*June*, 1950).

A radiation chart for use in calculating the rates of heating or cooling by long wave radiation of air layers in the lowest 100 m of the atmosphere, is presented. It takes account of the radiation due to CO_2 in a more satisfactory manner than does Elsasser's chart which applies to the relatively deep atmospheric layers dealt with in synoptic problems. As an example of the application of the chart, the rate of radiative cooling of the lowest 80 m of the atmosphere, just before dawn, is evaluated from published data for clear June nights of little wind in southern England. It is shown that, under these conditions, radiative exchanges in the air play a large part in cooling the air in the surface inversion layers. A.

551.573

1541. On evaporation from snow surface. H. KÖHLER. *Ark. Geofys.*, **1**, *Paper* 8, 159–85 (1950).

A mathematical investigation of the problem leads to two expressions for the rate of evaporation. One expresses E, the rate of evaporation from a surface assuming a certain distribution of water vapour near the ground, the other expresses E in terms of the water vapour content per cc at a certain height at a distance X from the edge of the evaporating substance in the direction of the wind. A comparison of observed values with those calculated according to the first formula shows that for negative values of E where water vapour content increases with height the assumption made regarding the distribution of water vapour near the ground is considered legitimate. But for positive values of E the theoretical values ar too small. In computing values by the secon expression the scatter of the measured values is ver great but the theoretical curve coincides approxi mately with the mean empirical curve so long as I is < 0. For $E > 0$ the figures show that this formul is not suitable for calculating evaporation on mountain, the sources of error being too great.

A. E. M. GEDDE

551.57

1542. Observation of precipitation with an air borne radar. E. J. SMITH. *Aust. J. Sci. Res. A*, 3 214–23 (*June*, 1950).

A radar set with its beam directed downwards ha been mounted in an aircraft and used for observatio of natural and artificially induced precipitation. I provides information on where the precipitatio originates within a cloud and the way in which i grows. A measure is obtained of the area anc duration of precipitation reaching the ground, anc an estimate of the precipitation rate. As an example of the use of this equipment, an account is given of a typical experiment in which precipitation wa artificially induced by seeding a cloud with dry ice. A

551.578.1

1543. The formation of rain by coalescence. E. G BOWEN. *Aust. J. Sci. Res. A*, **3**, 193–213 (*June*, 1950)

A theory is developed to account for the pheno menon of light rain falling from clouds above freezing level, based on the initial growth of cloud droplets by condensation followed by the growth of a small fraction of their number by coalescence. These grow in their ascent through the cloud until they are large enough to remain in suspension in the upward air current, after which they fall as rain. Experimental observations of rain from non-freezing clouds have distinguished two main types. The first of these shows an increase in drop diameter or rainfal intensity downward through the cloud, as would be expected if the drops followed a variety of trajectories within the cloud. The second type is one in which the drop trajectories tend to coincide, in which case there would be a maximum in the raindrop density and the rain water content at some defined height within the cloud. This has been verified qualitatively by radar observations and flight experiments. A.

551.578.1 : 551.594.25

1544. The electric scavenging of clouds. M. PAUTHENIER AND N. LOUTFOULLAH. *C.R. Acad. Sci., Paris*, **231**, 953–6 (*Nov.* 6, 1950) *In French.*

The possibility of a large charged water drop attracting smaller uncharged drops in a cloud is investigated. It is shown that particles will be attracted which are not directly in the path of the falling sphere and so the effective radius for collision is increased. Numerical calculations show that the release of charged water drops above a cloud or og would be a very uneconomic method of precipitating the water drops. J. M. HOUGH

551.578.9

1545. On the time lag in the precipitation of ice by silver iodide crystals. R. S. BRADLEY. Letter in *J. Chem. Phys.*, **18**, 1309 (*Sept.*, 1950).

551.593.9

1546. The light of the night sky, and its origin. J. GAUZIT. *Scientia*, **85** (*No.* 11) 267–71 (1950) *In French.*

A condensed survey of the night-sky problem, including reference to modern observing techniques, and factual knowledge derived from their use.

D. R. BARBER

551.594.14 : 778.3 : 539.16.08

Radioactivity induced from the atmospheric air, investigated with the photographic emulsion method. *See Abstr.* 1264

551.594.6 : 621.396.11

1547. Outline of a theory of radio scattering in the troposphere. H. G. BOOKER AND W. E. GORDON. *J. Geophys. Res.*, **55**, 241–6 (*Sept.*, 1950).

The theory of scattering by a turbulent medium is applied to scattering of radio waves in the troposphere. In the region below the horizon of the transmitter, energy is received (1) by diffraction around the curved surface of the earth (modified as appropriate by atmospheric refraction), and (2) by scattering from turbulence in the region of high field-strength above the horizon. At distances beyond the horizon that are not too great, (1) may be regarded as giving the mean signal received and (2) as giving the fading. However, contribution (2) usually decreases with distance more slowly than contribution (1). Beyond a certain distance, therefore, contribution (2) becomes predominant and the mean signal is no longer given by (1). Values of the scale of turbulence and of the departure of refractive index from the mean expected on meteorological grounds adequately explain the scattered field-strengths observed experimentally. A.

BIOLOGY 57/59

575.2 : 539.166

1548. The cytological effects of low intensity radiation. K. SAX. *Science*, **112**, 332–3 (*Sept.* 22, 1950).

Tradescantia plants can stand several *r* per day of gamma rays without significant increase in mutations (unlikely to be valid for animals). F. T. FARMER

578 : 612.8 : 621.389

1549. A differential vectorcardiograph. S. A. BRILLER, N. MARCHAND AND C. E. KOSSMANN. *Rev. Sci. Instrum.*, **21**, 805–11 (*Sept.*, 1950).

A vectorcardiograph was designed and constructed for the purpose of separating and recording the temporal components (*P* form, *QRS* form and *T* form) of the spatial vectorcardiogram in two planes. The equipment consists of a network to convert the patient voltages into an orthogonal set, a 3-channel l.f. amplifier, a synchronized timing unit, a dual-beam oscilloscope, a time marker, an electronically operated camera, and a simultaneous direct-writing recorder. A.

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612.743 : 621.317.75

1550. The analysis of action potentials in electromyography. P. BAUWENS. *Proc. Instn Elect. Engrs, Pt I*, **97**, 217–22 (*Sept.*, 1950).

The relationship between muscle activity and the nervous system, and the diagnosis of nervous disorders by abnormal muscle reactions to electrical stimuli, are discussed. Stimulation of muscles by electrical pulses produces "action potentials." Recording apparatus must reveal synchronization of these potentials in groups of muscles, and also be equipped with a "memory." Here, two needle electrodes, introduced into the muscle, lead to amplifiers whose outputs are fed to a monitoring loudspeaker and c.r.t., and also to a closed-loop magnetic tape recorder. The loop takes $1\frac{1}{2}$ sec to make a revolution; it then reaches an erasing head. This $1\frac{1}{2}$-sec "memory" is found sufficient since, when a waveform of interest is monitored, recording can immediately be stopped and "played back" automatically through an amplifier and c.r.t. Synchronized pulses can be counted with modified Miller-integrator circuits.

D. V. MABBS

612.844.23 : 535.317.4

1551. On the geometric aberration of the eye. A. IVANOFF. *C.R. Acad. Sci., Paris*, **231**, 526–8 (*Sept.* 4, 1950) *In French.*

It is shown experimentally that the aberration of the eye is, to a first approximation, spherical, although its optical system is not strictly spherical. Diagrams and graphs are given. R. A. WEALE

TECHNICAL MATERIALS 66/67

666.1.056.5 : 621.385.1.032.7

1552. The physical aspect of glass-metal seals in the electron tube industry. II. G. TRÉBUCHON AND J. KIEFFER. *Ann. Radioélectricité*, **5**, 243–58 (*July*, 1950) *In French.*

Using experimental techniques described in part I [see Abstr. 8396 (1950)] stress measurements for both glass alone and glass-metal joints are made under various annealing schedules. Knowledge of the physical properties of the glass and the metal yield an explanation of the curves and enable an optimum annealing schedule to be determined in each case.

R. O. DAVIES

669 : 548.73

1553. Apparatus for cutting metals strain-free. R. MADDIN AND W. R. ASHER. Note in *Rev. Sci. Instrum.*, **21**, 881–3 (*Oct.*, 1950).

PHOTOGRAPHY 77

771.535

1554. The combined effect of infra-red radiation and intensification upon the photographic latent image. L. FORTMILLER, T. H. JAMES, R. F. QUIRK AND W. VANSELOW. *J. Opt. Soc. Amer.*, **40**, 487–96 (*Aug.*, 1950).

The developability of some latent-image centres can be destroyed by the absorption of i.r. radiation (Herschel effect). Absorption of 1 quantum per centre is sufficient to destroy the developability of some centres, indicating that the removal of 1 Ag atom or *F*-centre is sufficient to destroy the developability of such a centre. Experiments have been carried out on motion-picture positive film to determine whether the developability of such centres can be restored by any of the various known methods of latensification. Experiments were also carried out to determine what effect latensification prior to the i.r. exposure has upon the Herschel effect. Both physical and direct development were employed. The degree of stabilization attained when latensification preceded i.r. exposure was calculated in terms of per cent difference between the change of density of the control and of the latensified film. The degree of restoration attained when latensification followed i.r. exposure was calculated in a similar way. The results indicate that, with the exception of bisulphite treatment, latensification procedures will not make developable any significant number of subimage centres which originally were smaller by one unit than the critical size necessary for initiating development. A.

772 : 537.533.72

1555. Application of the electron microscope to the study of photographic processes. G. BARONI AND C. CASTAGNOLI. *R.C. Ist. Super. Sanità*, **13** (*No.* 4) 360–5 (1950).

The behaviour of AgBr granules of normal emulsions has been studied under the action of various developers. It was found that all chemical developers, from ferrous oxalate to methol, hydroquinone, etc., produce filaments of metallic Ag from the granules affected by light. *P*-phenylenediamin also gives a filamentary structure, contrary to the results reported by Hall and Schoen. The granules developed by physical methods of prefixation and postfixation development have an entirely different appearance in some photographs. Attention is drawn to the behaviour of AgBr crystals under the electronic beam: progressive alteration brought about in the granules, appearance of protuberances of Ag and migration of Ag between granules in contact with one another are documented by some micr photographs.

778.3 : 539.1

1556. On the identification of high energy particl in electron sensitive plates. G. P. S. OCCHIALIN *Nuovo Cim.*, **6** (*Suppl. No.* 3) 413–28 (1949).

The potentialities of measurements of grain densit scattering and residual range for the identification c tracks in emulsions are surveyed. The range relatio of a singly charged particle is known but extension t multiply charged particles must be empirical o account of electron capture. The range measuremer also is valueless for the fast particles from stars sinc these cannot be followed the necessary distance Grain density is affected by fading, uneven develop ment and, near the minimum density, by the un certainty of the law of grain density *v.* velocity Scattering measurements require angles of scatterin significantly above an instrumental "noise" level c the method, they accordingly require large trac lengths at high energy, and so thick emulsions ar advantageous: the measurements can be extende beyond 1 BeV/c. The use of electrons for tests c the techniques is discussed. J. G. WILSO

778.67 : 777.

1557. The reproduction of colour photographs H. M. CARTWRIGHT. *Photogr. J. B*, **90**, 125– (*Sept.–Oct.*, 1950).

The characteristics of different processes are con sidered briefly, but colour half-tone, which allows o more accurate colour correction, is described i detail. The discontinuous half-tone structure i not generally apparent though it may sometimes be the cause of unwanted hue variations. A colou print on paper (which allows of retouching and the addition of artist's work) is the most acceptable form of original. "Additive" transparencies have a suitable range but their colours tend to be de-saturated; narrow-cut filters should be used in making colour-separation negatives from them. Integral tri-pack transparencies are popular but their high contrast range is a drawback. Direct screen negatives are generally used in the reproduction of colour prints on paper and corrections are made by fine-etching. The indirect process is often used in reproducing colour transparencies, partial correction being made by masking. The use of colour inks made to the British Standards specification should lead to better results when several different subjects are printed together. A.